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THE FEASIBILITY OF A NATIONAL VESSEL-TRAFFIC INFORMATION SYSTEM--ETC(U)
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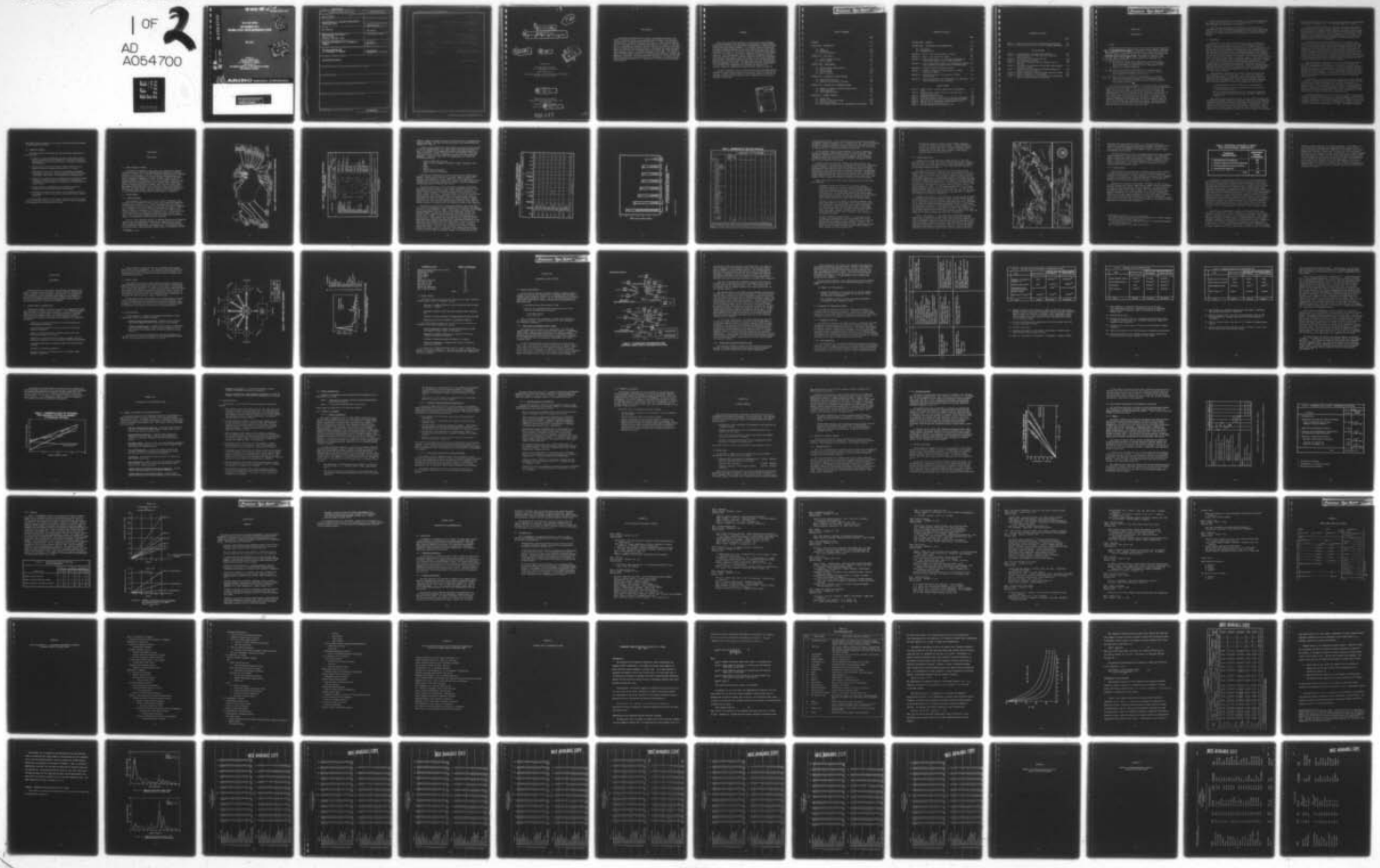

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FINAL STUDY REPORT

THE FEASIBILITY OF A NATIONAL VESSEL-TRAFFIC INFORMATION SYSTEM

May 1978

Prepared for
MARITIME ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE
under contract to
THE MARINE EXCHANGE OF THE SAN FRANCISCO BAY REGION
SAN FRANCISCO, CALIFORNIA

ARINC RESEARCH CORPORATION

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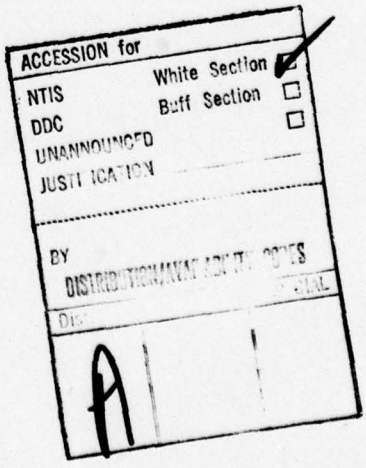
FOREWORD

This final study report provides an overview of the work performed by the Marine Exchange of the San Francisco Bay Region and ARINC Research Corporation to determine the feasibility of establishing a National Vessel-Traffic Information System (NAVTIS). It provides a base for determining if present fragmented methods for reporting anticipated and actual vessel movements into and out of the nation's ports can be expanded from today's port-centered systems to a nationally integrated system of vessel-movement reporting. The considerations leading toward the recommended national system are summarized and the technical alternatives that were considered are described. The expected costs and revenues of the preferred National Vessel-Traffic Information System at each stage of the recommended implementation process are provided. The report also describes the administrative and management activities to be undertaken during the establishment of the system. The recommended plan includes the formation of a national cooperative association of marine traffic reporting agencies.

The Marine Exchange of the San Francisco Bay Region and ARINC Research Corporation express their thanks to the officials of the Maritime Administration, to marine reporting agencies, and to many others in industry and government throughout the country for their cooperation during the performance of this study.



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CHAPTER ONE

INTRODUCTION

1.1 SCOPE

ARINC Research Corporation, under contract to and with the cooperation of the Marine Exchange of the San Francisco Bay Region (MESFBR), performed a study to determine the economic, operational, and technical feasibility of establishing a commercially oriented, national vessel intelligence and shipping traffic information system. The study was sponsored by the Maritime Administration (MarAd), U. S. Department of Commerce, under Contract Number 6-38047. The overall goals of the study were to:

(1) Determine the feasibility of implementing a national system for providing timely, comprehensive, reliable, and compatible vessel intelligence and shipping traffic information to the entire U. S. maritime community.

(2) Determine the feasibility of developing a national repository of information related initially to U.S. port activity and ultimately to worldwide port activity.

(3) Seek a consensus regarding the establishment of a national non-profit organization dedicated to the cooperative improvement of port-centered information services and maintenance of the national repository.

The initial project plan was based on a one-year effort, during which surveys were to be conducted at major U. S. ports on the Pacific and Atlantic Coasts and the Gulf of Mexico. Near the end of the first year, after completion of the salt water port surveys and analyses, the Maritime Administration, with the concurrence of the contractors, decided that the Great Lakes ports should be included in the surveys and study results. The "fourth coast" of the United States has become a significant international waterborne transportation area during the last decade with the expansion, enlargement, and modernization of the St. Lawrence Seaway to all of the Great Lakes and connecting river systems. It was believed that a study of a national ship traffic information system would not be complete without the inclusion of the Great Lakes.

After official approval from the MarAd, six of the major Great Lakes ports were surveyed, and the results were incorporated in the previous data, analyses, and conclusions of the study.

This final report presents the results of the overall surveys, identifies the current shortcomings in obtaining ship traffic information at many U. S. ports, and offers recommendations for the establishment and operation of a viable, cost-effective national ship traffic information system.

1.2 BACKGROUND

During 1976, more than 700,000,000 tons of cargo, representing a commodity value of more than $200 billion, moved through the nation's ports. This massive movement of goods with its attendant commercial activity has an enormous impact upon the nation. As vessel speeds increase and the efficiency of loading and unloading increases, steamship operators and agents, freight forwarders, custom-house brokers, ship chandlers, and a myriad of other marine service and supply companies are recognizing the need for timely and accurate information on the interport movement of ships. Accurate advance notice of a vessel's arrival or departure, scheduled berth, and vessels in port have a significant impact on the costs incurred by and the effectiveness of the port-centered maritime community. In addition, the collection and analysis of ship movement data on a local and national basis is a necessary prerequisite to intelligent planning for improved future operations and new facilities. There are also many federal and state government agencies that require this data to provide effective controls for ship safety, environmental protection, emergency planning, and other similar functions.

Vessel-movement reporting at the nation's ports historically has been performed on a port-by-port basis -- each reporting system was developed independently. As discussed later, there are currently nine formalized port information agencies providing ship movement data to their local maritime communities. These agencies are marine exchanges which have been organized in a variety of categories that include:

- Centralized agencies that are financially self-supporting
- Centralized agencies that are subsidized by a port authority or local government agency
- Non-centralized organizations that are sponsored or supported by local maritime organizations, Boards of Trade, Chambers of Commerce, etc.

The functions and associated revenues of these marine exchanges stem from service offerings ranging from supplying vessel arrival and departure information and telephone answering or message relaying services, publishing port directories, selling advertising space in publications, and providing general maritime intelligence information. The extent of these services varies between marine exchanges and ranges from manning lookout stations to note the passage of vessels in and out of harbors to performing

all the usual activities required for collecting, reporting, and publishing intelligence information to the local maritime community or public.

The marine exchange methods of information collection and reporting vary from the sophisticated, computer-supported operations, such as the port of Seattle, to elemental manual operations of entering data on cards or blackboards and resorting to the telephone for dissemination of vessel in-port location information. Lack of uniformity is very evident in the industry. The potential benefits achievable through the application of computer and telecommunications technology and services are yet to be realized at most U. S. port communities.

As presented in the survey results portion of this report, those responsible for servicing ships or handling cargo in practically all the U. S. ports surveyed generally believed that improved accuracy and timeliness of ship traffic reports would result in higher efficiencies and reduced costs for their operations. Although the marine exchanges discussed above are currently providing vessel location information to their clients or members, the activities are fragmented and limited to only a fraction of the nation's ports. An approach to potentially improving the accuracy and timeliness of vessel location reporting involves the formation of a nationwide integrated vessel reporting system which would serve as a national repository for vessel location information.

Other transportation industries, such as the railroads and airlines, have organized national organizations or associations to address the need for standardization and uniformity in their data reporting practices and have been able, as a consequence, to introduce significant improvements in the reporting and coordination of equipment movements that have benefited the entire industry. It would appear that collective action on the part of marine exchanges in the form of a national association organized to pursue common interests and goals would benefit the maritime industry as well.

Although there are no national vessel traffic data systems currently in operation, systems employing centralized computer data files that can be accessed by the maritime community at large are in operation. An example is the recently publicized "Ship Data File" of the Maritime Data Network Company, a joint venture of Lloyds of London, Lloyds Register of Shipping, Van Omerenn, Fairfield Maxwell, and Marine Management Systems. This system provides subscribers with vessel data characteristics of the world's ships in excess of 4,000 gross registered tons.

The Maritime Administration, acting under its charter to improve the efficiency and profitability of the U. S. merchant marine, contracted with the Marine Exchange of the San Francisco Bay Region (MESFBR) to study the economic, operational, and technical feasibility of establishing a national information system for collecting and disseminating traffic information concerning commercial vessels using U. S. ports. The MESFBR contracted

with ARINC Research Corporation to provide technical engineering support in the conduct of the study.

1.3 TECHNICAL APPROACH

The tasks required to achieve the study goals were determined to be as follows:

1. Survey U. S. ports to determine how and by whom vessel intelligence and shipping traffic information is currently collected, disseminated, and used, what needs exist, and what are the available resources.

2. On the basis of the survey results, define requirements for improving existing information services at U. S. ports.

3. Conceptualize alternative systems to accommodate improvement requirements and select a preferred system concept on the basis of economic, operational, and organizational considerations.

4. Determine the probable cost of implementing the preferred system concept and estimate revenues and benefits on the basis of affordability and marketability considerations derived from the survey results.

5. Develop a plan for implementing the preferred system and establishing an associated national organization.

6. Distribute a summary of the results of the feasibility study to participants in the initial survey, the purpose being to seek a consensus.

The subsequent chapters of this report describe the activities performed in each task area, the task results, and the overall conclusions and recommendations resulting from the study.

CHAPTER TWO

PORT SURVEY

2.1 PORTS INCLUDED IN SURVEY

The major port complexes in the nation are illustrated in Figure 1. During the course of this study, MESFBR and ARINC Research Corporation surveyed 27 of these ports. Traffic information requirements were gathered through on-site interviews with existing marine reporting agencies and users of shipping information, including steamship companies and agents, freight forwarders, custom-house brokers, pilots, tugboat operators, terminal operators, and stevedores. The port complexes surveyed included Boston, New York, Philadelphia, Baltimore, Hampton Roads, Charleston, Savannah, Jacksonville, Port Everglades, Miami, San Juan, Tampa, Mobile, New Orleans, Houston/Galveston, Los Angeles/Long Beach, San Francisco, Honolulu*, Portland (Oregon), Seattle, Alaska*, and the Great Lakes ports of Cleveland, Toledo, Detroit, Chicago, Milwaukee and Duluth/Superior. A list of the ports and individuals surveyed appears in Appendix A.

2.2 SURVEY RESULTS

2.2.1 General Results

The information developed from the ship traffic information users included current information needs, sources, and transmission mechanisms (publications, telephone, etc.). Those interviewed were also queried on the adequacy of current information sources and the relative importance they attributed to the various kinds of information available or used. Table 1 presents a consensus of the various users with respect to the relative importance of certain key information items. The estimated time of arrival (ETA) is the singular most important item for most of the users. The accuracy and timeliness of ETA information has an important impact on the efficiency of most maritime operations.

Of the 27 port complexes surveyed, 9 featured ongoing port-information agencies that were recognized in their marine communities as the ship-traffic reporting organizations. Personnel of these existing agencies were interviewed in depth about their operations. They cooperated fully in providing data, including annual revenue, number of employees, services

* Surveyed by mail.

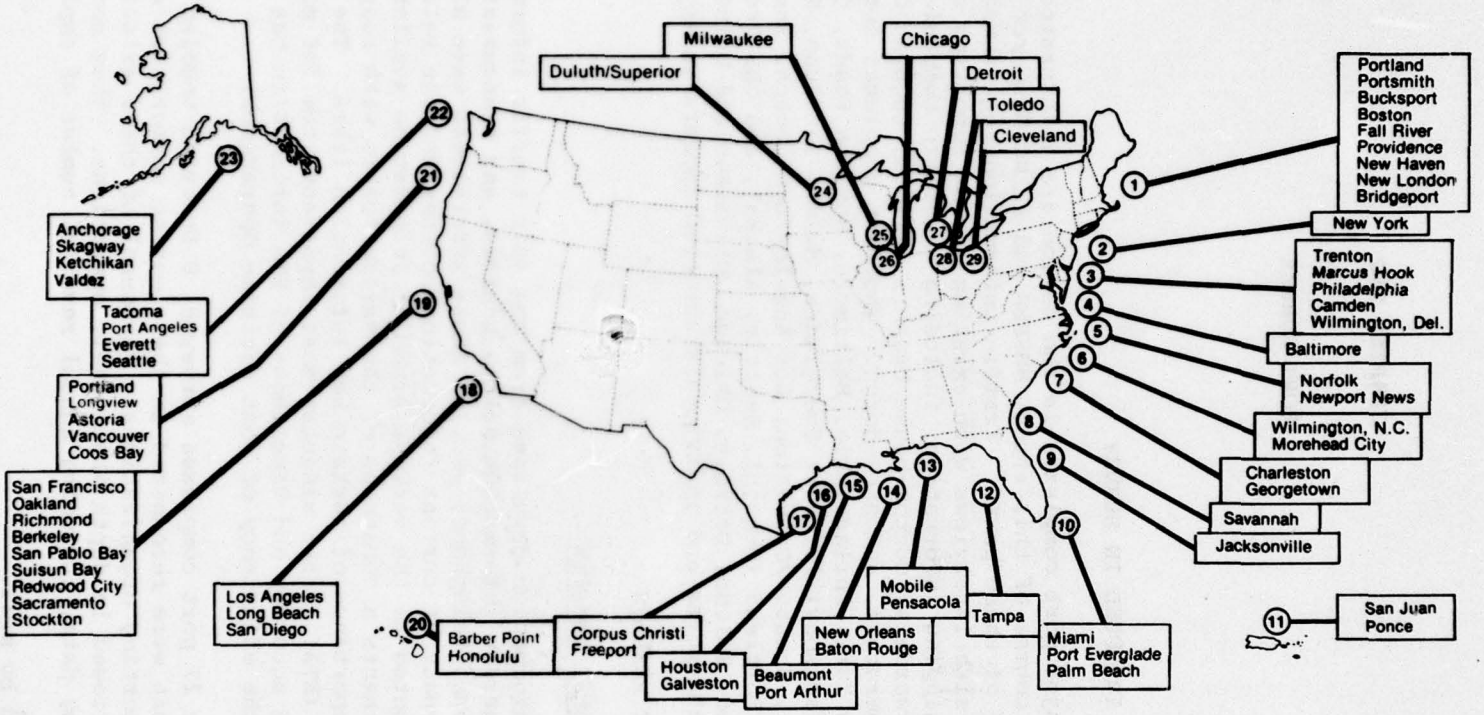


Figure 1. IDENTIFICATION OF 29 MAJOR PORT COMPLEXES

Table 1. SURVEY RESULTS — RELATIVE IMPORTANCE OF INFORMATION ITEMS

ULTIMATE USERS	TYPES OF VESSEL INFORMATION SERVICES								
	Primary Real Time								Primary Summary
	Arrival Time		Depart Time		Locate		Duration in Place		D = Daily A = Annual W = Weekly Q = On Querie M = Monthly
	ETA	ATA	ETD	ATD	Term	Ber	Est	Act	
Pilots and Lookouts	12	3	11	4	7	6	8		Rate Basis — MA
Steamship Agents/Owners	1	12	2	6	5	10	4	7	Voyage and Loading Record — A
Charterers and Their Agents									
Containers and Packaging									Arrivals — MA
Terminals Operators	12		9				10		ETA, ETD Inter (SC) — D
Forwarders/Brokers	12	6	7	5		11	8		Arrivals — MA, ETA/ETD, Berth — D
Consignees/Shippers (Bulk)	12	11							
Chandlers	12	10	7			11			ETA, Berth, ETD — D
Bunkering	11	10				9	8		Fuel Statistics — MA, ETA — D
Cleaning and Exterminating	12					11	10		Arrivals — MA, ETA, Berth, ETD — D
Launch Services	12				11		10	9	Arrivals — MA
Ship Repair and Maintenance	11						10		Arrivals — MA
Surveyors	10					9			Arrivals — MA
Insurance	12	9	10	8	7		11		Voyage Record — A
Salvage									
Coast Guard					12				Arrivals — MA
Attorneys	12					11	10		ETA, Berth, ETD — D
Bankers									
Truckers	12		10			11	9		ETA, Berth, ETD — D
Barging and Towing	12					11	10		ETA, Berth, ETD — D
Railroads	11				12				Arrivals — MA, ETA, Berth — D
Newspapers and Media	12		11			10			ETA, ETD, Berth — D
Customs	12		10						ETA, ETD — Q
VTS	12	5	11	6	10	9	8		Arrivals — MA, ETA, Berth — D
EBURS									Term Utilization — D,W,M,A
AMVER		9		10	12				Arrivals — MA
USMER		11		10	12				Arrivals — MA
Corps of Engineers					11	10			Arrivals — MA
Foreign Consuls	12		11		9	10	8		Arrivals — MA

EXPLANATION: The estimated relative importance of vessel information services to a particular user is represented by a number between 12 (most important) and 1 (least important). A blank indicates irrelevancy or unknown.

LEGEND: ETA: Est. Time Arrival; ATA: Act. Time Arrival; ETD: Est. Time Departure; ATD: Act. Time Departure; Term: Terminal or Anchorage; Ber: Berth; Inter: Interface functions with other users or external files; SC: Ships Characteristics.

offered, numbers and types of users, and characteristics of communications methods available. The data collected from these nine organizations are summarized in Table 2.

The port survey showed that vessel-traffic reporting services offered at the nine representative U. S. ports differ only slightly from port to port. All provide, as a minimum, basic marine intelligence services to users in printed or verbal (telephone) form. Most publish a daily list of vessels in port, arrivals, departures, vessels due, and anticipated departures. Typically, these lists are mimeographed and include the following information:

- Name of vessel and call sign
- Type of vessel (steamship, motorship, tanker, passenger, etc.)
- Flag
- Berth
- Agents
- Origin and/or destination
- Date of arrival or departure

The specific information and services offered at the various ports appears to depend on such factors as the total number of annual vessel arrivals, total tonnage in various commodities, trade categories, distance from adjacent ports, and other locational and operational factors; accordingly, the nine port complexes have sought to develop information services that meet the needs of their users.

The annual revenues of each of the marine exchanges, derived from the services listed in Table 2, show a large variation from port to port. Some perspective of the significance of this variation in shown in Figure 2, which provides a correlation between vessel arrivals at each marine exchange and revenue. The Marine Exchange of the San Francisco Bay Region's total annual revenue divided by total yearly vessel calls at the Golden Gate shows an average of $59; the lowest average was Hampton Roads at $9.45, while the average among all exchanges was $34. However, direct fees for ship reporting varied greatly, and total income often included a variety of revenue sources not directly related to ship reporting.

The survey of users and port information agencies showed that there was a need for information on vessel movements at other ports, particularly at ports in close proximity. Table 3 lists typical commercial and Government marine organizations that are found in every major port complex, the estimated number of interport telephone calls generated for each ship arrival, and the number of reports generated both routinely and on a special basis. Table 3 shows that of an average of 160 organizations in each major port, approximately 100 telephone calls per ship arrival are made between port cities or municipalities to exchange information on estimated and actual movements and other intelligence. There is, however, no coordinated means within each port to acquire or tabulate interport vessel information. Each user, when faced with the need for "outside" information, tends to resort to his own sources rather than the local traffic information agency (if existing). The information may be sought by calling a local agent or steamship company or by contacting sources

Table 2. SURVEY RESULTS — CHARACTERISTICS OF EXISTING PORT-INFORMATION AGENCIES

				SERVICES OFFERED					COMMUNICATION METHOD					
Port Complex	Vessel Traffic Reporting Agency	Reporting Agency Revenue Per Year	Number of Employees	Marine Intelligence Services	Vessel Movement	Telephone Answering	Harbor Activity Membership	Port Directory with Advertisements	VHF or Microwave	Teletype	Telecopier	Computer	Lookout	VTS
San Francisco	Marine Exchange San Francisco Bay Region	225K	13	P,T	P,T	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes
New York	Maritime Association Port of New York	300K	13	P,T	P,T	Yes	Yes	Yes	No	Yes	Yes	No	No	No
Philadelphia	The Philadelphia Marine Exchange	155K	10	P,T	P,T	No	Yes	Yes	Yes	No	Yes	No	Yes	No
Baltimore	Baltimore Maritime Exchange	126K	5	P,T	P,T	No	No	No	Yes	No	No	No	No	No
Boston	Maritime Association of Greater Boston	60K	2	P (Limited) T	P,T	No	No	No	No	Yes	Yes	No	No	No
Portland	Merchants Exchange of Portland	53K	11	P,T.	P,T	Yes	Yes	No	Yes	No	No	No	No	No
Hampton Roads	Hampton Roads Maritime Association	35K	6	P,T	P,T	No	No	Yes	No	No	No	Yes	Yes	No
Los Angeles	Marine Exchange of Los Angeles and Long Beach Harbor, Inc.	218K	11	P,T	P,T	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Seattle	Port of Seattle	N/A	2	P,T	P,T	No	Yes	No	No	Yes	No	Yes	No	Yes

P = Publication; T = Telephone

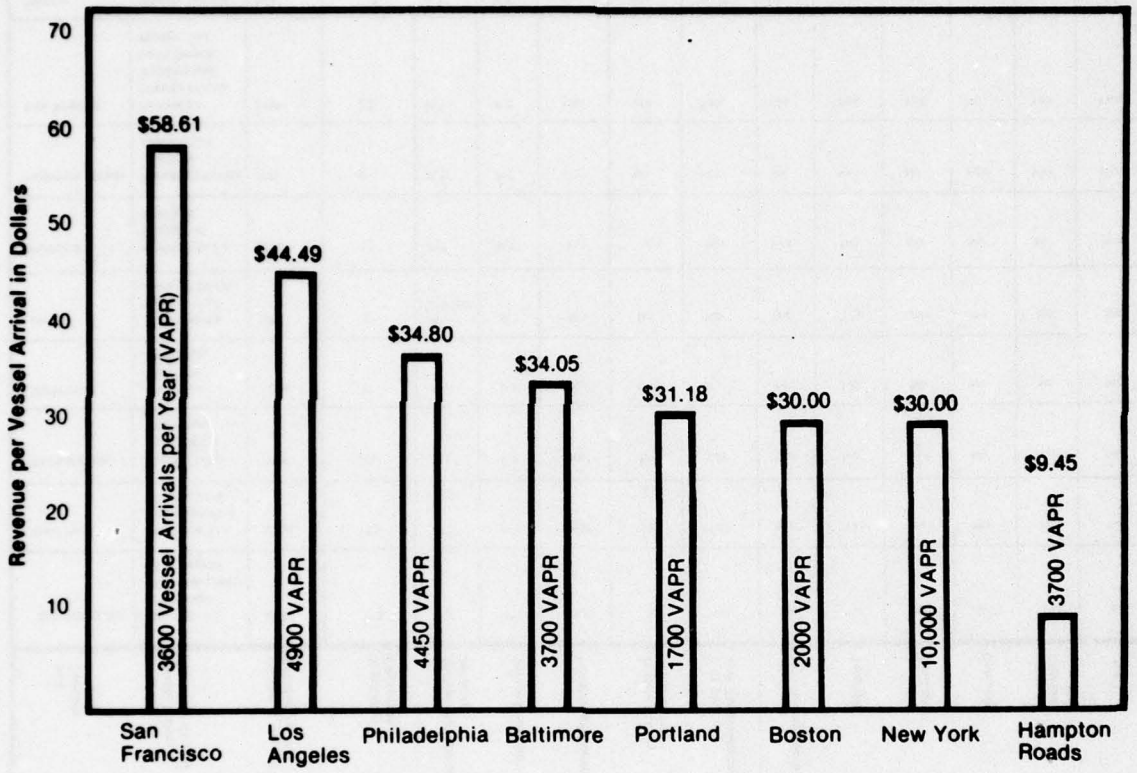


Figure 2. REPORTED REVENUE* PER VESSEL ARRIVAL AT EXISTING MARINE EXCHANGES

* From all services.

Table 3. MEMBERSHIP SERVICE PROFILE

				Intelligence and Information Requirements per Port Complex							
				Standard Summaries				Special Reports			
Group Code	Local Members	Separate Accounts Average Number per Port Complex	Interport Telephone Calls per Arrival*	Daily	Weekly	Monthly	Annual	D	W	M	A
1	Pilots Towing Docking	8	16	8	8	8	8	—	1	2	8
2	Steamship Owners Steamship Agents Freight Forwarders Custom House Brokers Importers/Exporters	26	52	26	13	7	26	3	6	12	24
3	Chandlers Bunkerers Shipyards Exterminators Cleaners Launch Services Salvaging Charts Watchmen Corrosion Control Weighers Architects Instruments	39	9	39	39	10	10	—	1	5	10
4	Insurance Bankers Attorneys Chambers of Commerce Developers CPA's Physicians	26	5	2	3	6	12	1	1	5	10
5	Warehousing Stevedores Terminal Operators Crane Rental Packaging Refrigeration Dredging Container Suppliers Elevators	22	3	6	6	11	22	2	2	4	8
6	Overland Transport Barge Operators	8	1	1	2	3	8	1	1	2	4
7	Retailers Wholesalers Distributors Dealers	21	5	5	5	10	20	1	2	5	10
8	Publishers Newspapers Printers Data Processing	3	0.5	2	2	2	2	0.3	0.3	0.3	1
9	Government Agencies (C.G., Customs, etc.)	7	14	7	7	7	7	1	2	7	7
	Totals (Per Complex)	160	103	96	85	64	115	9.3	16.3	42.3	82
	Grand Totals (All Complexes)	3680	9,375,000 (All Arrivals)	2208	1955	1472	2645	214	375	973	1886

*Interport telephone calls per group per port complex per arrival are estimated from the survey results augmented by subsequent telephone interviews with representatives of the group. The number given is the product of the average number of separate accounts in the group per port complex and the estimated number of interport calls per arrival made by a typical member of the group. The number of interport calls would be higher if it were not for the fact that many groups call either the local agent, a local forwarder/broker, a local pilot, a local harbormaster, or a local marine exhange

at the appropriate port. It was reported that this process often produces inaccurate, outdated information or no information at all. Often the necessity to acquire interport information occurs outside normal business hours and, because no organized interport information service exists, the information, if received at all, is received too late to be acted on.

In the opinion of many of those surveyed, the current fragmented methods of interport vessel-movement reporting need improvement. There was general consensus of the user community, as well as the agencies involved in gathering and disseminating information, that a nationally coordinated effort was required if vessel-movement information at any port is to be available at all ports.

Survey results also show that existing procedures requiring the cross referencing of vessel-activity information are very slow. Information is often redundant, and statistical data required by users of maritime information at each major port area is often quite difficult to acquire. These inefficiencies result largely from manual techniques associated with recording and searching written files, typically 3x5 cards. Although most marine exchanges agreed that computerization would provide them with the needed capabilities for more efficient operations at the local level, each claimed a lack of financial resources to develop an individual system.

Other significant points that came to light during the surveys were the following:

- Although the principal function of the existing traffic information agencies is to report ship arrivals and departures, most provide other services such as telephone answering, shore-to-ship message communications, the publishing of port directories, etc. to the maritime community and thus are able to utilize their personnel and facility resources more efficiently. These additional services are important sources of revenue, supplementing subscription income from ship movement reports.

- Carriers or their agents engaged in waterborne commerce, both foreign and domestic, are required to file reports with government regulatory, inspectional and safety agencies describing the itinerary of their vessels and their cargo. The reports include such basic data as ship's name and identifying number, size, flag, owner, agent(s), schedule, ports of call, etc. These government agencies require frequent, timely updates of the location of ships.

- In order to obtain accurate information on anticipated ship arrivals, the transportation or service groups whose livelihood depends upon servicing ships, cargos, crews and passengers usually contact steamship company operators or agents. The operators or agents usually resort to radio communications with ships' masters to update estimated times of arrival (ETAs) of ships destined for the particular port.

- The greatest concern of users of vessel-traffic reporting services is reliability of ETA reports. In many instances it is difficult if not impossible to predict accurately a ship's arrival time several days ahead. However, a good service is considered to be one that provides regular, increasingly accurate updates of the original ETA.

2.2.2 Great Lakes Ports

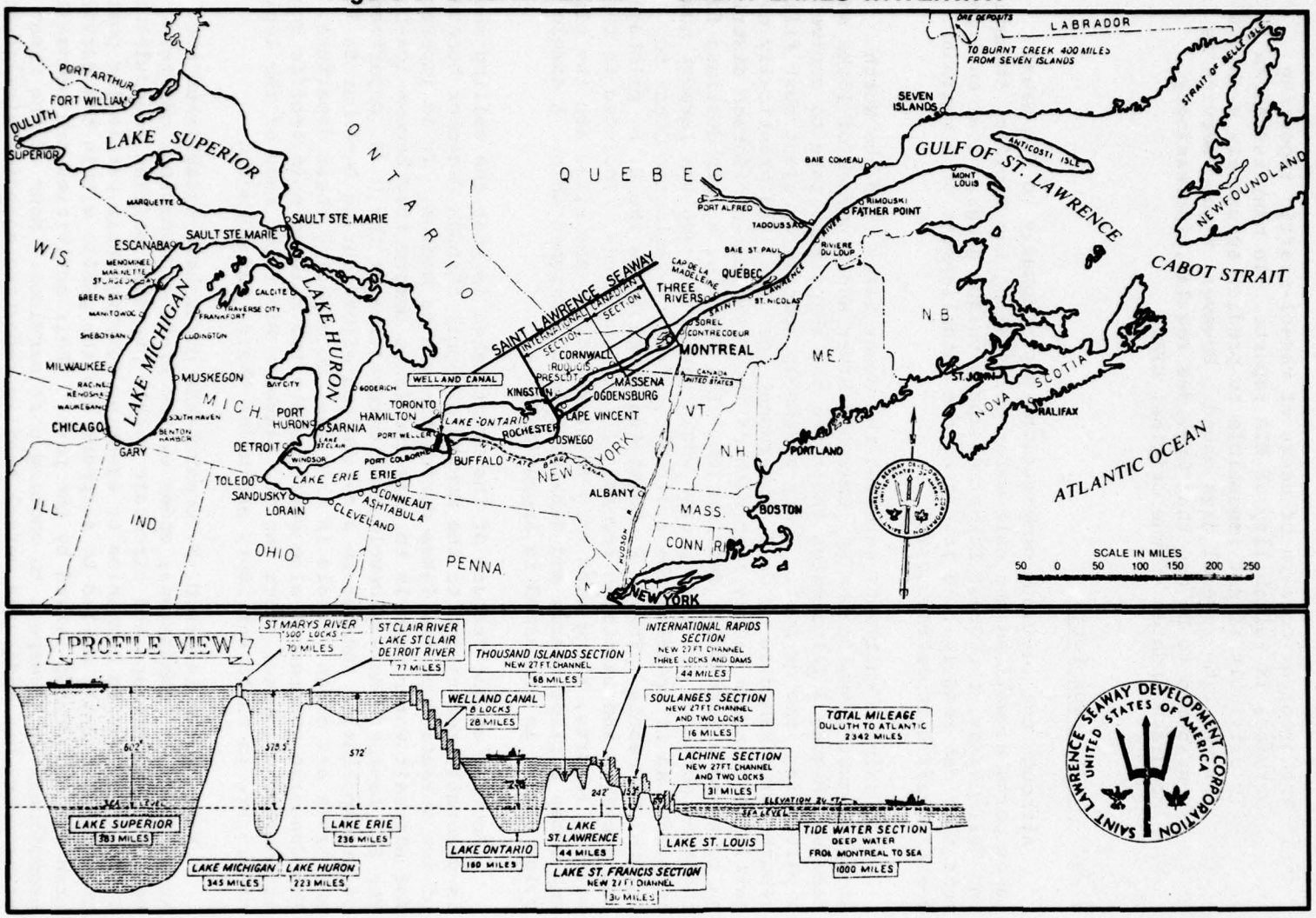
Although the previous observations apply equally to the Great Lakes ports as well as the salt water ports along the Pacific, Atlantic, and Gulf Coasts, the Great Lakes present a unique geographical environment that can readily lend itself to the establishment of a regional vessel-traffic reporting system.

All ships ("salties") entering the Great Lakes from the North Atlantic must traverse the St. Lawrence River and a series of locks and canals. Figure 3 illustrates the route the ships must take to arrive at a particular lake or port. Every steamship company or agent must file reports with Canadian or U. S. government agencies, and practically every saltie must engage pilots from each of the Great Lakes pilotage districts en route to a particular destination. For example, a ship destined for the twin ports of Duluth/Superior would have to engage the largest number of pilots as it traveled the 2,342 miles from the Atlantic Ocean to Duluth, Minnesota. The U. S. Coast Guard regulates the U. S. pilotage and receives and maintains records of these services. Included in the pilot's reports, along with ship identity, flag, and size, are the places and times a pilot boards and debarks from an assigned ship. A sample pilot report is contained in Appendix B.

Another unique feature of the Great Lakes is that the sailing season is generally restricted to the months of April through December because of ice formation on the lakes during the winter months. It is imperative for all salt water vessels to exit the lakes before they become ice-bound. The St. Lawrence Seaway Development Corporation of the U. S. Department of Transportation engages in a determined effort during December to locate and track all ocean vessels in the lakes to expedite their departure. The Canadian government also performs a vital role in ship traffic regulation and pilotage, since the St. Lawrence River and many of the locks and canals are in their territory and under their jurisdiction.

Many of the larger U. S. Great Lakes ports have established port authorities or commissions, under either state or municipal charters. Most of them prepare and circulate weekly overseas sailing schedules and lists of steamship companies or agencies serving their particular ports. These are normally mailed to shippers and the public within the service area and hinterland served by the port. Their activities are primarily promotional with respect to ongoing port services. None of the Great Lakes ports has dedicated vessel traffic reporting agencies similar to

Figure 3. ST.LAWRENCE — GREAT LAKES WATERWAY



those salt water ports listed in Table 2. In the Great Lakes, any individual or organization requiring current information on ship arrivals usually contacts the steamship company agent by phone. The agent, in turn, may contact the master of his company's vessel by radio to obtain an estimated time of arrival.

The Great Lakes also feature a ship/shore automated VHF radio-telephone system operated by the Lorain Electronics Corporation. For cooperative ships or subscribers, Lorain also provides an automatic reporting service (ship's location and other relevant data) to steamship companies or their agents. A description of the system appears in the July 1976 issue of Marine Engineering/Log in an article entitled "Great Lakes Get a Fully Automated VHF Radiotelephone System".

2.2.3 National Users

Another aspect of the survey was to determine the potential customers of a National Vessel-Traffic Information System (NAVTIS) who would be interested in aggregated or national summaries of vessel traffic information. Included in this category were those organizations or groups that required interport ship movement data. Telephone interviews were conducted to supplement the data collected from on-site surveys.

The market for national vessel-traffic information includes national and multinational corporations, communications common carriers, international agencies, and federal, regional, and state agencies. An investigation of the number of organizations fitting these categories disclosed the 386 potential national clients shown in Table 4.* A less conservative figure would be provided by the 2,000 subscribers of the journal of Waterborne Commerce of the United States published by the U.S. Army Corps of Engineers. This journal provides extensive summaries of waterborne commerce and vessel traffic statistics for all the ports in the U.S. A spread of approximately 400 to 2000 would then represent the extremes of the potential national marketplace for vessel-traffic information.

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* Government Organizations of U.S. Coastal States
U.S. Senate Committee on Multinational Corporations List of Major Shippers
National Industrial Traffic League Indices
U.N. Directory and U.S. State Department Studies of International Agencies with Maritime Interests
American Association of Port Authorities Indices

Table 4. POTENTIAL NATIONAL CLIENTS FOR THE NATIONAL ASSOCIATION

Prospective National Clients	Approximate Number in Population
1. Multinational Corporations	200
2. Federal, Regional, and State Agencies	170
3. Communications Common Carriers	4
4. International Agencies	12
Total	386

Approximately 60 persons from 25 major U. S. federal organizations were contacted to determine whether they required national vessel traffic data, or if these data were available from a centralized source, whether they would be interested in acquiring reports. Included were offices from the Departments of Agriculture, Commerce, Defense, Energy, State, Transportation, and Treasury, the Export-Import Bank, Federal Communications Commission, Federal Maritime Commission, Federal Reserve Board, International Trade Commission and Water Resources Council. A list of these organizations appears in Appendix C. Most of the persons contacted expressed a definite interest in timely records of ship traffic activity in U. S. ports, and, where possible, would prefer to obtain this data from more than one source (ostensibly to verify or determine the accuracy of statistical information). The general procedure for procuring reports was to have their libraries subscribe to the available service. A spot check of some of the federal libraries indicated that their budgets were relatively large, and a fee of $200 to $300 per annum would be a reasonable charge for NAVTIS summary reports.

Corporations or organizations involved in multinational maritime activities, in addition to those surveyed at the various ports, were contacted to ascertain their interest in national or interport vessel traffic reports. Appendix D provides a list of these organizations. The responses from these sources were non-conclusive. Organizations that are directly involved in waterborne transportation, through necessity, have to establish procedures or methods for determining the location of particular ships. In many cases, a series of communication links have been established, like those of a chain, to disseminate ship traffic information. Maritime service or supply organizations in a particular port typically contact the individual

steamship company agents for ETA and ETD information. These agents, in turn, collect their information by communicating with agents at other ports or directly with ships until, eventually, the necessary ship traffic information is obtained. Whether by "trial and error" or a determined effort on the part of those concerned, a system that "works" finally emerges. There has been an investment in time, dollars, and other resources to make the system responsive to the needs of the concerned maritime organizations -- and a competitive approach for supplying ship traffic information will not be given serious attention until it is demonstrated. Thus, most of those contacted were not willing to express any commitment, even on an informal basis, to a hypothetical NAVTIS. However, for those organizations currently paying for a ship traffic information service, the responses of interest were positive.

CHAPTER THREE

REQUIREMENTS

The data collected in the survey of originators and users of ship traffic information was classified in terms of content, justification, quality, quantity, format, frequency, and security. This process led to the definition of the functional requirements for an integrated National Vessel-Traffic Information System (NAVTIS) which would serve both local port organizations or marine exchanges as well as users interested primarily in nationwide information.

3.1 SYSTEM GENERAL CHARACTERISTICS

For analysis purposes, the nation's ports were grouped into 29 major port complexes as previously shown in Figure 1. The information requirements for each port complex were estimated on the basis of the survey responses from the ports visited. The characteristics of a National Vessel-Traffic Information System which would respond to current operational short-comings and satisfy these requirements are summarized as follows:

- Communications capability from and to any participating port (for messages and reports)
- Inquiry/response capability of one to two hours for vessel-movement information
- Security of proprietary files and data to ensure that only authorized personnel have access
- Capability to satisfy each port's needs for summary data and aggregation capability to satisfy national reporting requirements
- A standard nomenclature and message format for reporting vessel movements
- Automatic file-updating capability
- Automated access to international (non U.S. waters) vessel-movement information

Figure 4 depicts a simplified version of a NAVTIS system concept which fulfills these requirements. As illustrated, data are entered into an on-line central processor by each of the port regional offices, and vessel traffic reports are extracted from the system in accordance with the needs of each office.

3.2 TRAFFIC VOLUME

Since messages through the system would be concerned primarily with vessel movements between major ports in the United States, a mathematical model was developed to predict the volume of such traffic to be expected in the future (See Appendix E). To check their accuracy, these predictions were compared with historical information relating to vessel arrivals at New York and New Orleans (a combination representing about 22 percent of total national vessel arrivals). The results were very satisfactory, as the sample for New York shown in Figure 5 demonstrates.

Storage and processing requirements for an automated National Vessel-Traffic Information System were developed from these predictions. For the type of information flow expected, the input/output character volume predicted for 1980 shows that about 150 to 200 million characters would be transferred over a National Vessel-Traffic Information System.

3.3 FILE STRUCTURE

A file structure to support the information requirements of the system would include the following elements:

- Temporary Vessel Activity Records - temporary vessel activity log on each commercial vessel reported by any port complex
- Internal, Permanent File - permanent vessel activity information derived from the temporary vessel activity records for use by participating ports that require statistical summaries of port activity

An initial version of a condensed file structure containing only the most essential information elements from the aforementioned records contains 182 characters and would appear as follows:

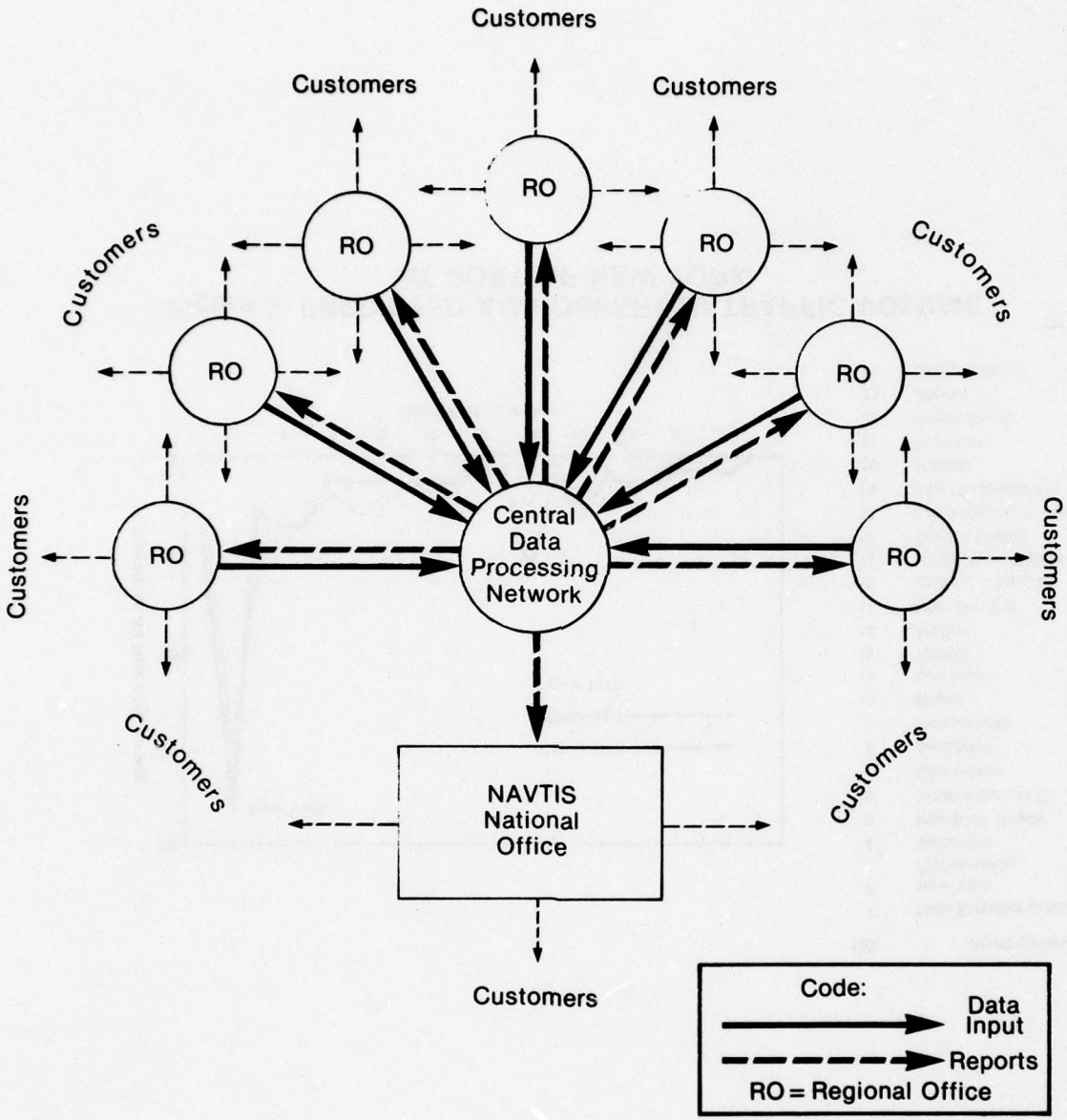
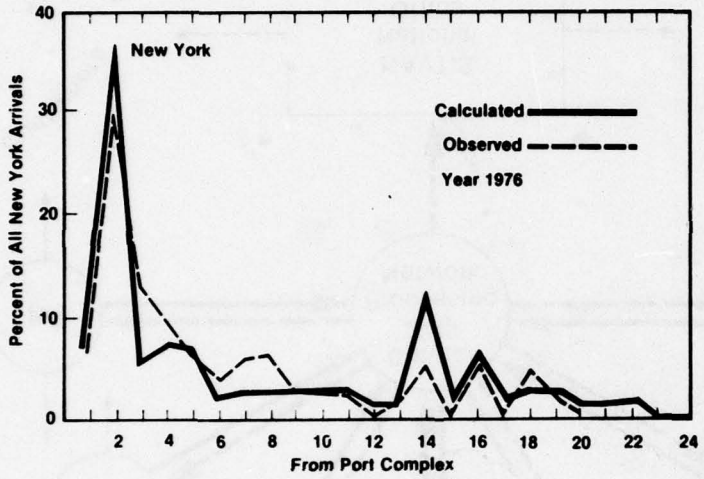


Figure 4. SIMPLIFIED NAVTIS CONCEPT



NO.	PORT COMPLEX
1	New England Coast
2	New York
3	Philadelphia
4	Baltimore
5	Hampton Roads
6	Wilmington, N.C.
7	Charleston
8	Savannah
9	Jacksonville
10	Miami
11	San Juan
12	Tampa
13	Mobile
14	New Orleans
15	Sabine — Neches
16	Houston — Galveston
17	Corpus-Christi
18	Los Angeles — Long Beach
19	San Francisco Bay
20	Hawaii
21	Portland
22	Puget Sound
23	Alaska
24	Great Lakes

Figure 5. PREDICTED AND OBSERVED TRAFFIC VOLUME AT PORT OF NEW YORK

Information Items	Number of Characters
Reporting Agency/Current Port of Call	21
Reporting Date/Time	14
Vessel Name	21
Vessel Number	6
Vessel Type	4
Flag	4
Agent/Owner/Charterer	21
Last Port of Call	21
Next Port of Call	21
Location In Port	21
ETA or ATA (Date/Time)	14
ETD or ATD (Date/Time)	14
TOTAL	182

3.4 REPORT CONTENTS

The general report contents that are likely to be of most interest to regional office clients or customers include:

- Listings of vessels scheduled to arrive during the next few days and berth assignments
- Listings of vessels in port and their current status, location, etc.
- Listings of vessels scheduled to depart during the next few days
- Elapsed time in port of vessels at a particular facility

The general report contents that are likely to be of interest to customers of the NAVTIS organization include:

- Periodic summaries of vessel arrivals and departures at each port complex, region, coast, or the nation
- Summaries of vessels calling at U.S. ports, by any of the preceding information categories
- Location of particular vessels calling at U.S. ports
- Statistical summaries of elapsed time in port of vessels at particular facilities

An example of a computer-generated report on vessel location and status is presented in Appendix F. This type of report is currently being offered on a subscription basis to the Puget Sound maritime community by the Port of Seattle.

CHAPTER FOUR

ALTERNATIVE SYSTEM CONCEPTS

4.1 SYSTEM CONFIGURATIONS

The existence of efficient, reliable commercial computer services, coupled with national and international telecommunications networks provides a ready technical solution for the implementation of a National Vessel-Traffic Information System. The two relatively attractive computer-based communications system configurations considered for this application were:

- A Specialized Value Added Network (S-VAN)
- A Central Data Processing Network supported by one of the following telcommunications services:
  - Value Added Network
  - Direct Dial-Up

These alternatives are illustrated in Figure 6 and discussed in the following sections. Detailed descriptions of each alternative are contained in Appendix G.

4.1.1 Specialized Value Added Network (S-VAN)

The S-VAN service provides, on a leased basis, the three most common elements basic to any on-line processing activity: telecommunications lines, computer hardware/software, and terminal equipment. Inasmuch as the full management responsibility for hardware, software, and telecommunications services lies with the vendor, this alternative is very attractive since it eliminates a requirement for in-house technical staff.

In the S-VAN configuration, the individual or regional offices require only a teletype data terminal to input data or retrieve reports from a remote data-processing system maintained by the vendor. There are no practical limitations to the number of terminals or regional offices that can be incorporated in the system. Also, future participants can be added simply by obtaining a data terminal and assigning a code number of identification to access the "Vessel Traffic" program; no

Alternative Systems

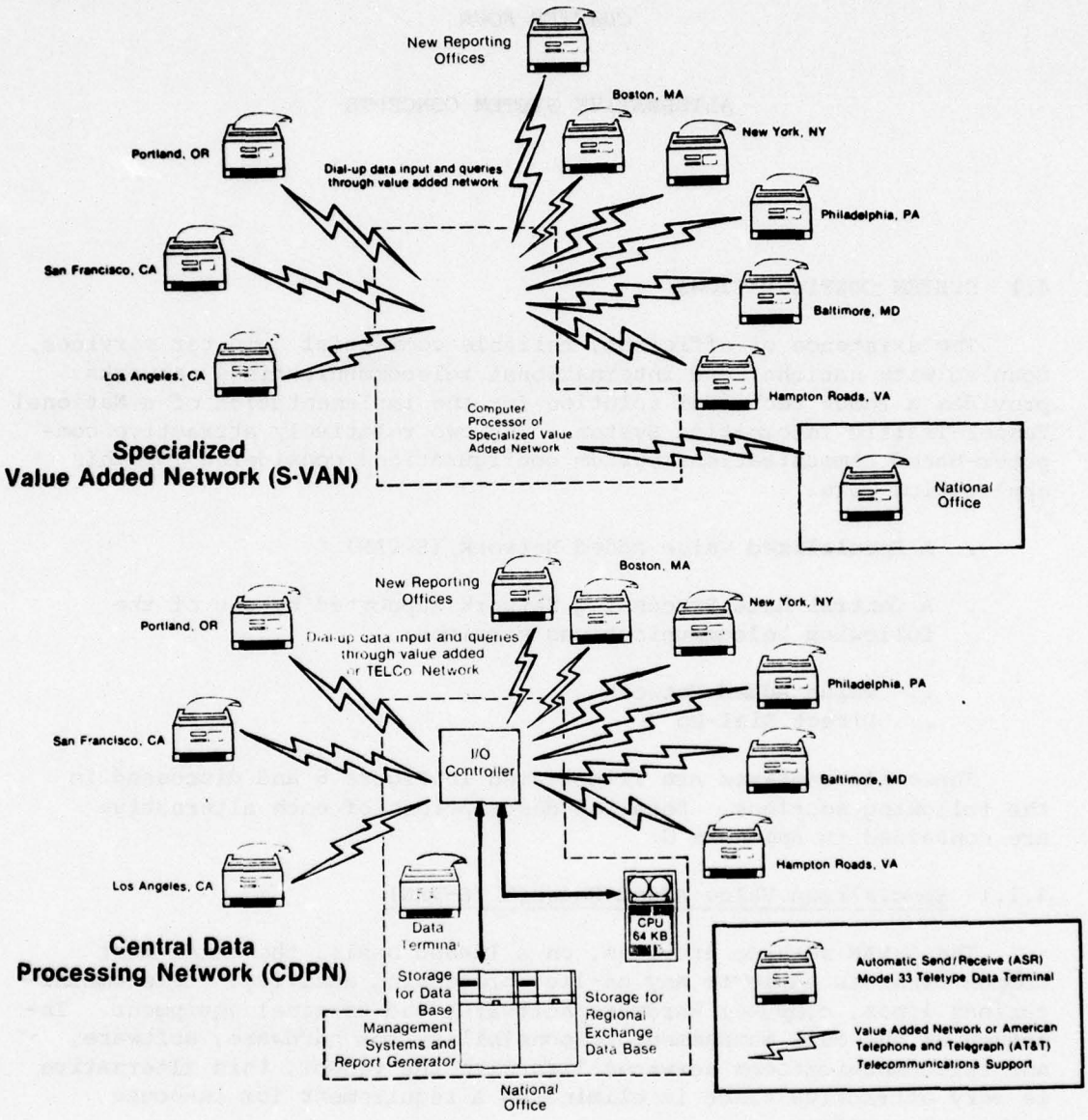


Figure 6. ALTERNATIVE CONFIGURATION FOR NATIONAL VESSEL-TRAFFIC INFORMATION SYSTEM

interruption of the system operation need take place. As a matter of fact, a terminal with an acoustical coupler can be operated from a private residence or any telephone hand set. The terminal operator does not require any previous specialized training or knowledge of computers. A secretary or typist can learn to operate the terminal after brief instructions and a few practice sessions. The entry or retrieval of data will require only minutes of an operator's time, and should fit within the normal workload of any small office operation.

Ship arrival and departure information would be typed into the terminal daily, including corrections of estimated times of arrival and departure and the updating of ship files. Daily reports can be extracted from the central processor by entering instructions via the teletype terminal.

The national office of the NAVTIS would be equipped initially with the same type of terminal as the regional offices. The national office would be able to monitor and exercise management and security control over the system by assigning code or identifying numbers to each of the regional offices, thus providing them access to the vessel-traffic software program residing in the central processor. Reports from the EDP vendor relevant to the status and extent of use of any program used by a participating member could be furnished to the national office. The national office would also be in a position to modify the software, expand the data bases, increase the number and variety of the reports, and generate statistical analyses and summaries of the data. If the report summaries became extensive, savings in telecommunications and data processing costs could be effected by using various high-speed print-out services available from practically all of the time-share computer service companies.

In its initial configuration, the NAVTIS organization would not require a full-time staff and the activities could be undertaken by an existing exchange or facility currently providing vessel-location information. The operation of the terminal and generation of reports would not necessitate special skills or the continuous attention of the operator. The modification or development of software could be purchased from service organizations as the need arose. The largest demand for labor is likely to stem from promotional and marketing requirements. A novel method for demonstrating the system to potential regional office participants is the use of a portable teletype terminal with an acoustical coupler, allowing operation of the system through any hand-set telephone.

4.1.2 Central Data Processing Network (CDPN)

The principal difference between the CDPN concept and the S-VAN concept is the CDPN requires the central host processor (computer system) to be owned and operated by the NAVTIS organization.

In this alternative, the central host processor also serves all data terminals within the national system. Access to the network is available by direct dial-dedicated lines, or a VAN. A VAN differs from the previously discussed S-VAN in that the VAN offers only the basic telecommunications line service. Each user must provide data terminals to interface with the VAN which, in turn, links up with the NAVTIS host computer. The data terminals can be leased from several service companies.

The functional operations of the regional office and the national organization would be similar to those described previously for the S-VAN.

In summary, the CDPN approach:

- Requires the NAVTIS to own and operate the central computer processor and peripheral equipment, and to provide a staff for operation and maintenance.
- Can accommodate increases in data processing requirements at relatively small increases in cost.

4.2 COMPARISON OF ALTERNATIVE SYSTEMS

The S-VAN and CDPN alternatives were compared with respect to technical features and costs; see Table 5. The basic technical capabilities of the two system approaches are similar for the applications referred to in this study; however, differences do exist for such features as system reliability, operational requirements, and capital costs.

4.2.1 Comparative Features

As indicated in Table 5, the S-VAN operation is relatively free from implementation and maintenance problems and has backup features that provide very high data-management reliability. The Central Data Processing Network requires a communications specialist to operate and maintain the central processor and peripheral equipment, and has no backup EDP capability unless a redundant system is acquired. As the NAVTIS expands its data base and substantially increases its processing time for analyses and reports, the costs of S-VAN service are likely to increase at a greater rate than the "in-house" central data processing network.

4.2.2 Cost Comparisons

Cost comparisons for the S-VAN and CDPN alternatives are depicted in Tables 6, 7, and 8. Table 6 shows the one-time development and implementation costs for the NAVTIS national office for each of the system alternatives analyzed. The significant difference between alternatives lies in the fact that leasing a time-share computer service eliminates the need

Table 5. COMPARATIVE FEATURES OF ALTERNATIVE SYSTEMS FOR NAVTIS

SYSTEM	ADVANTAGES	DISADVANTAGES
Specialized Value Added Network (S-VAN) (Service Offering By Computer Time-Share Company)	. Full System Support (Vendor) . Little Capital Investment . Short Term Commitment . Low Risk of System Failure . Reliability/Availability Very High . Dynamic Circuit Routing . Error Checking at Cities Served as well as Throughout the Network . Quick Response Time of Data Through System . Does not require Telecommunications Personnel to Monitor Program and System Operations	. Long Distance Call Required for Cities not Local to Input Node . No Cost Advantage Through Increased Usage
Central Data Processing Network with VAN Support (owned system) (CDPN + VAN)	. Same Advantages as above for Data Telecommunication Network . Growth at Little Additional Cost . Can Perform Other EDP Functions at Little Additional Cost .Low Telecommunications Costs	. Long Distance Call Required for Cities not Local to Input Node . Requires Relatively Large Capital Investment . Requires Communications Specialist for Support/Management . No EDP backup in case of failure
Central Data Processing Network with Direct Dial-Up System (owned system) (CDPN + DDU)	. Growth at Little Additional Cost . Can Perform Other EDP Functions at Little Additional Cost	. Relatively High Communications Line Cost . No Error Checking of Data . Requires Relatively Large Capital Investment . Requires Communications Specialist for Support/Management . No EDP backup in case of failure

Table 6. NATIONAL OFFICE DEVELOPMENT & IMPLEMENTATION COSTS

Item	Specialized VAN	Central Data Processing Network	
		VAN Support	Direct Dial Up
Computer & Peripheral Hardware (1)	None	$1,870/mo[2]	$1,870/mo[2]
Computer Maintenance	None	450/mo[3]	450/mo[3]
Telecommunication Install and Initial Hookup Charges	less than $2/mo[2]	10/mo[2,4]	less than $2/mo[2]
Application Software[5]	325/mo[2]	325/mo[2]	325/mo[2]
Total	325/mo	$2,655/mo	$2,645/m0

(1) Computer system has full interactive capability with any user terminal. Hardware includes CPU with 64K Word Memory, 50M byte Disk with Controller, Magnetic Tape with Controller, 16 Channel (Async.) Multiplexer, Supervisory Console, Line Printer and Operating & Data Management Software. Industry quoted costs which include initial installation and integration of system by vendor.

(2) All costs are predicated on amortization of initial capital costs over 5 years @ 10% annual interest.

(3) Industry quoted rate.

(4) Installation charges for data modems, multiplexers, terminal access controllers and other interface devices.

(5) Based on 4 man months of Development & Programming & Computer Charges.

Table 7. NATIONAL OFFICE OPERATIONS COSTS

Item	Specialized VAN	Central Data Processing Network	
		VAN Support	Direct Dial Up
Data Terminal Rental	$ 85/mo (1)	Included	Included
Telecommunications	25/mo (2)	$513/mo (3)	$230/mo (4)
EDP Staff	None	2500/mo (5)	2500/mo (5)
EDP Services	240/mo (6)	Included	Included
Total	$350/mo	$3,013/mo	$2,730/mo

(1) Data terminals are automated send/receive model 33 teletypes with transmission speed of 10 characters per second or equivalent. Modem Data Access Arrangement (DAA) and maintenance included in monthly costs.

(2) Business phone rental

(3) Industry quoted rental costs of telecommunications interface devices to computer (telenet based line, telephone connections, modems and terminal access controller).

(4) Industry quoted rental costs of telephone lines and modems (computer interface)

(5) Salary and overhead of one computer/operator communications specialist.

(6) Criteria predicated on six (one-page) monthly summary reports from total data files (industry estimate of $40 per page).

Table 8. AVERAGE REGIONAL OFFICE OPERATIONS COST

Item	Specialized VAN	Central Data Processing Network	
		VAN Support	Direct Dial Up
Business Phone Rental	25/mo	25/mo	25/mo
Data Terminal Rental(1)	85/mo	85/mo	85/mo
Telecommunications	Included	40/mo(2)	120/mo(3)
EDP Services (4)	220/mo	Included	Included
Total	$330/mo	$150/mo	$230/mo

(1) Data terminals are automatic send/receive (ASR) model 33 teletypes with DAA and maintenance, or equivalent.

(2) Based on average connect time rates of medium density city for VAN telecommunications. Average daily connect time was estimated as 15 minutes.

(3) Based on average connect time rates of U.S. common telecommunications carriers

(4) Based on daily data entry and daily reports of vessels in port, five-day ETA forecast and five-day ETD forecast.

for purchasing and installing hardware. Indirect costs, such as office space, utilities, etc., were not included in the analysis because equipment requirements of both alternatives can be readily accommodated in any small office.

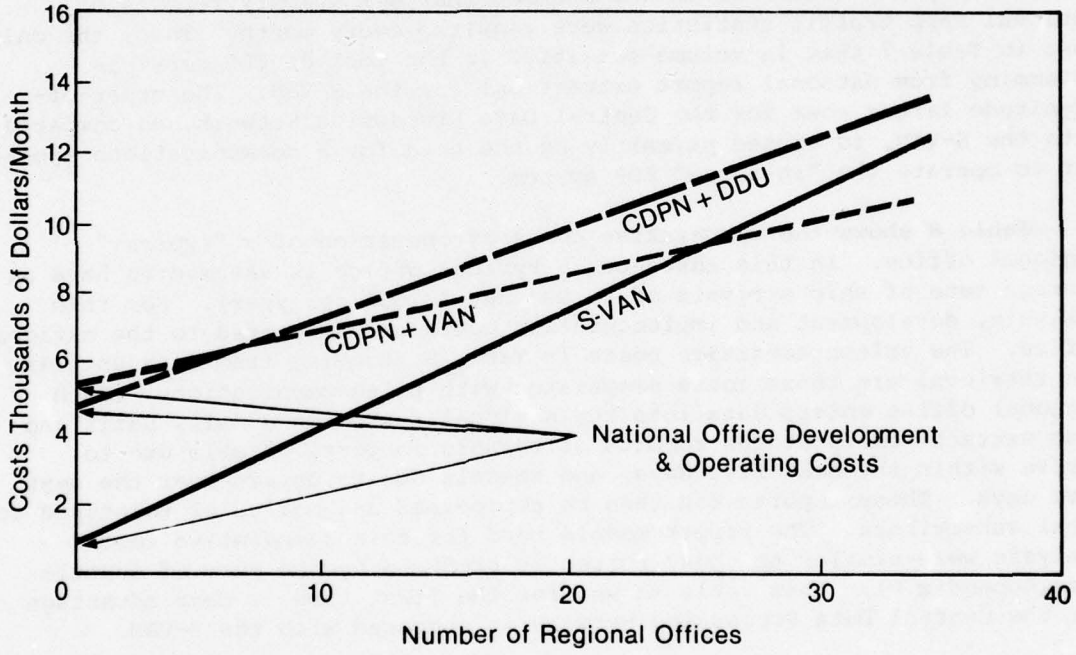
Table 7 shows a comparison of the NAVTIS national office operational costs for the candidate approaches. These costs are related to the EDP and telecommunication functions required for data entry and report generation of the NAVTIS operations. In all cases, data are entered into the host processor by the regional offices. The national office extracts reports but does not enter data into the system. Thus, for the CDPN, summary reports can be generated within the facilities of the national office. For the S-VAN case, however, the reports must be extracted from the vendor's processor. This can be accomplished via the national office data terminal, or by taking advantage of high-speed print-out equipment at the vendor's facilities. This latter alternative provides some cost advantages if the reports are long. Returning to the comparative cost analysis shown in Table 7, it was assumed that six summary reports of national ship traffic statistics were required every month. Thus, the only cost in Table 7 that is volume sensitive is the cost of EDP services (stemming from national report extraction) for the S-VAN. The order-of-magnitude larger cost for the Central Data Processing Network, as compared with the S-VAN, is caused primarily by the need for a communications specialist to operate the "in-house" EDP system.

Table 8 shows the comparative costs of operation of a "typical" regional office. In this instance, a typical office is assumed to have an average rate of ship arrivals of 10 per day (3,650 per year). For this analysis, development and implementation costs are allocated to the national office. The volume-sensitive costs in Table 8 stemming from data entering and retrieval are those costs associated with telecommunications. Each regional office enters data into the national system on a daily basis and also extracts daily status reports of vessels in port, vessels due to arrive within the next five days, and vessels due to depart over the next five days. These reports can then be reproduced and mailed or teletyped to local subscribers. The report models used for this comparative cost analysis were similar to those currently produced by the Port of Seattle (See Appendix F). This table shows, for the first time, a cost advantage for the Central Data Processing Network as compared with the S-VAN.

The combined costs for national and regional offices are depicted in Figure 7. By adding the costs of the regional offices to the national office costs a full picture is offered of the overall cost trade-offs for each candidate system. The chart shows clearly that for a limited number of regional offices (approximately 25 or less), the S-VAN system is less costly. The Central Data Processing Network with VAN support shows a cost advantage when the number of regional offices exceed approximately 25.

Considering the limited number of regional offices (initially the marine exchanges) anticipated in the early stages of the NAVTIS operation, the combined considerations of technical and cost comparisions indicate the S-VAN system as the recommended implementation alternative for the NAVTIS. At such time as the number of regional office participants exceeds 25 to 30, consideration should be given to converting to a Central Data Processing Network configuration.

Figure 7. COMBINED COSTS OF NATIONAL AND REGIONAL OFFICES VS NUMBER OF REGIONAL OFFICES



CHAPTER FIVE

DESCRIPTION OF THE PREFERRED SYSTEM

5.1 SUMMARY OF PREFERRED SYSTEM CHARACTERISTICS

As discussed earlier, the recommended approach for implementing the National Vessel Traffic Information System is the Specialized Value-Added Network System. This approach provides the necessary technical characteristics for meeting the NAVTIS requirements at the lowest initial cost and with a minimum of development risks. The system's features are summarized as follows:

- Hard Copy Communications Capability. Hard copy (both inputs and outputs) is available directly from the teletype which is provided at each regional reporting unit.

- Inquiry/Response Capability. System provides interactive communication with the central computer and automatically responds to legitimate information requests by printing out reports.

- Expandable System. System is part of a large computer time-share/telecommunications complex and can readily accept expanded data requirements and additional users.

- File and Data Security. Unique code addresses protect proprietary information, and qualified participants can access only the data files to which they are assigned.

- Reliability. System has fail-safe provisions for files, and back-up EDP capabilities.

- Ease of Operation. Special skills are not required to operate the terminals. Data can be stored and edited before transmission to the central processor.

- Summary Reporting and National Reporting Capability. Central computer provides summary and aggregation capability.

- Standard Nomenclature and Message Format. System software ensures compliance with standard nomenclature and format rules.

- Automatic File Updating. System data-management software provides file up-date and retrieval capability.

- Access to International Vessel-Movement Information. System has standard interface for international telecommunications protocol.

5.2 SYSTEM OPERATION

The operation of the preferred system is expected to proceed as follows:

1. Each regional office will communicate with the S-VAN system via a teletype terminal located in the office. The regional office operator will dial the system number and use a coded identification address to access the proper program in the central computer. Upon verification by the system (answer back), the operator can enter data or extract reports.

2. On a predetermined schedule, vessel arrivals, departures, and in-port inventories will be entered on paper tape (off-line operation of the teletype terminal) and, following the "hand shaking" protocol described above, transmitted to the NAVTIS central processor. A similar procedure will be used for updating or correcting files.

3. When a regional office requires vessel movement information from the NAVTIS central processor, the request will be made via the teletype terminal by an on-line question and answer procedure. If a proper request is made, the computer will automatically transmit the requested report to the terminal.

4. The NAVTIS central processor will be programmed to produce summary reports for each exchange. Again, these reports can be obtained by request through the regional office terminal.

5. The national office will be able to obtain reports on its terminal in the same manner as the regional offices or use the high-speed printout capabilities of the "Time-Share" service vendor. These reports will generally be different from those for the regional offices, and will include such information as summaries of national aspects of vessel traffic and residence in U. S. ports.

6. The national office will monitor the system activities, assign the code identifications to the participants, modify or develop new software, and administer the system.

7. The regional and national offices will periodically receive time/billing information from the S-VAN vendor by which costs incurred can be monitored. In addition, cost per transaction information is available.

5.3 SYSTEM IMPLEMENTATION

The plan for implementing the preferred system encompasses two 12-month phases as follows:

Phase 1 - Organization, Prototype System Development/Demonstration and Initial Marketing

Phase 2 - Initial System Implementation and Operation

These phases are described in the following sections.

5.3.1 Phase I - 12 Months

5.3.1.1 Initial Organization

The present fragmented state of vessel-movement reporting at the nation's ports, combined with the fact that there is no central organization to coordinate such reporting on a national basis, requires that certain organizational activities take place before any attempt is made to tie existing or potential marine exchanges together into an on-line telecommunications system. The objective of the organization phase, therefore, is to synchronize the activities of the present individual marine exchanges for the purpose of developing a coordinated sequence of future activities that will ultimately result in the installation of an integrated National Vessel-Traffic Information System. The two major goals of the organization phase are to form an Industry Advisory Committee and subsequently to form a National Association of Marine Exchanges. In order to accelerate the educational process of informing the industry of the potential benefits of a NAVTIS, an on-site demonstration followed by a technology-transfer conference for all interested parties should be conducted.

An Industry Advisory Committee, consisting of one member from each existing marine exchange, should be formed to provide an initial focal point for accomplishing an orderly sequence of tasks necessary for implementation of the National Vessel-Traffic Information System. The advisory committee would be organized on an ad-hoc basis and would not be a legal entity. Each member of the committee would keep his own organization aware of the committee's proposed actions and secure agreement to such actions. Other activities to be undertaken by the committee would include:

- The development of standard operating procedures to be used by each participant (i.e., standard formats, codes, nomenclature, etc.).

- The review of business plans developed by each participant for the purpose of suggesting improvements based on their collective experience.

- The development of a business plan for the formation and operation of a National Association of Marine Exchanges. The National Assocation's business plan would also describe the marketing strategy to be employed to obtain sufficient revenues to cover costs.

- Participation in the planning and demonstration of a prototype NAVTIS as outlined in the next section.

5.3.1.2 Prototype System Development/Demonstration

A successful demonstration of the technical aspects of a prototype NAVTIS that embodies the essential characteristics of the preferred system would provide considerable impetus to obtaining new members for the National Association and would enhance the marketing strategy. The essential tasks required for a prototype demonstration are:

1. The preparation of preliminary specifications and operational arrangements
2. The selection of a specialized value added network/time share computer vendor
3. The development of prototype application software. The software developed during this prototype effort should be designed to satisfy actual perceived report requirements as closely as possible.
4. The leasing of data terminals for a representative number of existing marine exchanges that volunteer to partake in the demonstration
5. Testing the prototype system to obtain sufficient performance data for a definitive evaluation

The results of the demonstration would then be disseminated to the maritime industry. The technology-transfer conference mentioned in Section 5.3.1.1 would be a proper vehicle for presentation of the demonstration test results. MarAd's sponsorship of this development effort would expedite the implementation program.

5.3.1.3 The National Association of Marine Exchanges

The Industry Advisory Committee should, upon the approval of the boards of the participating marine exchanges, incorporate the National Association of Marine Exchanges to become the successor to the committee. The National Association will be a legal entity and will, in accordance with its charter, act as the central coordinating agency for the further implementation of the National Vessel-Traffic Information System (NAVTIS).

The National Association will act as the focal point for each marine exchange's participation in system development throughout the program.

The association will also act in an advisory capacity to the Maritime Administration, keeping that agency informed of system development and seeking its support in areas of mutual interest. The National Association will supervise subsequent phases of the implementation plan.

5.3.1.4 System Expansion and Marketing

The National Association would be faced immediately with the need for expanding its membership and obtaining customers. A series of tasks to be undertaken by the Association include:

- Solicit industry and government clients for the National Association in accordance with the developed business plan

- Offer invitations to appropriate organizations at additional ports to become members of the National Association and to participate in the NAVTIS. Examples of possibly appropriate organizations are a port authority or commission, Chamber of Commerce or Board of Trade, pilot association or a currently "non-operating" maritime club or association.

- Negotiate with groups, organizations, or individuals at U. S. port locations where exchanges do not exist to supply ship traffic reports, using where possible those who currently collect this data for their own purposes. Establish data collection and terminal entry operations and quid-pro-quo inducements for this "cooperative" effort. For example, supply "free" leased communications terminals and arrange to have them access reports on their own data.

- For non-participating port areas, produce reports that can be marketed locally through the National Vessel-Traffic Information System (NAVTIS). Use a mail campaign and/or local direct marketing on a commission basis.

- Encourage the establishment of new regional marine exchanges. Apply a flexible approach with marketing support and sharing of revenues until a regional exchange is self-supporting.

- Evaluate potential expansion of information elements that are transferred over the national network (i.e., periodic reviews of information needs).

- Evaluate the merits of expanding the national network to interface with appropriate international maritime intelligence networks (e.g., Lloyds).

5.3.2 Phase II - 12 Months

As previously indicated, the initial NAVTIS service features have been anticipated in the development of the prototype system. However, if the National Association decided to change or expand the reports, the computer software would require further development. As soon as this is accomplished, the regional members of the NAVTIS and the national office can commence business by leasing and installing data terminals. Initially, to limit administrative and clerical costs, it is recommended that the national office be co-located in one of the major marine exchanges such as New York or San Francisco.

During this phase the National Association should:

- Continue efforts to enroll all of the major U. S. port complexes into the NAVTIS
- Continue marketing efforts for national clients
- Review the operation of the national network in terms of the degree to which national information needs are satisfied. The association will review the data-processing and telecommunications services that are then available and will modify the system as required to ensure that current state-of-the-art technology is used wherever necessary to satisfy the information needs of its members and clients.

CHAPTER SIX

ECONOMIC ANALYSIS

With the preferred system configuration identified and its cost of implementation and operation estimated, the next concern of the study was to determine the system's affordability to potential users. The approach taken in analyzing the economic aspects of the NAVTIS consisted of the following steps:

- Determine the costs associated with implementing and operating the recommended system
- Identify the potential sources for generating revenues (i.e., customers of the system)
- Project the revenues needed to offset system costs and estimate total potential revenues available
- Develop a cost-revenue projection for the implementation plan described in Chapter Five (Section 5.3)

The results of these analyses are presented in the following sections.

6.1 SYSTEM COSTS

As indicated in Chapter Four, the nominal cost of the preferred configuration of the NAVTIS has three elements:

. National Office Development and Implementation (One-time cost amortized over five years)	$325/mo.	$3900/yr.
. National Office Operation	$350/mo.	$4200/yr.
. "Typical" regional or local marine exchange operation	$330/mo.	$3960/yr.

These costs are associated with the nominal telecommunication and data processing functions of the NAVTIS. Each regional office is assumed to have an average traffic volume of 10 ship arrivals per day (3,650 per year). In relative terms, the average cost of inputting data and extracting reports

(ETA, ETD and ships in port) for the regional offices is between $1.00 and $1.20 per ship arrival.

National office operation costs are more sensitive to the number of summary reports extracted rather than overall traffic volume. The figure shown above is based on 6 summary reports per month. Special reports requested by any client would incur additional costs. However, these would logically be directly chargeable to the client. Eventually, a rate sheet for specific special services would be developed and offered to customers. There is another basic assumption associated with the above figures: the regional offices initially participating will be existing marine exchanges and NAVTIS participation can be integrated into the normal activities of a marine exchange office without the need for additional staff. This premise can be supported by the following points:

- The marine exchanges are currently providing vessel-location information and the benefits of the NAVTIS (discussed in Chapter Seven) will motivate these organizations to participate in the system.

- Computer-based operation of the vessel-reporting clerical functions will provide increased labor productivity as compared with generally current manual operations. The resulting additional staff time available could be applied to support marketing or customer services.

6.2 SOURCES OF POTENTIAL REVENUE

The sources of potential revenue associated with operation of the NAVTIS can be grouped into two categories: regional services and national services. These categories are discussed in the following sections.

6.2.1 Regional Services

The types of organizations or maritime service groups that are potential customers of services from the regional offices are those listed in Table 3 of Chapter Two, which showed that there are some 160 separate potential customers for an average port complex.

With the introduction of a "computerized" vessel traffic reporting system, it will be possible to serve these customers with timely information on local and interport vessel activities, by phone, teletype, or hard copy reports. Membership or report subscription rates of 15 to 25 dollars per month could be charged for these services. These rates are within the amounts offered by existing marine exchanges for similar vessel intelligence reports and are within the survey-developed "willingness to pay" range indicated by most persons interviewed who require accurate, timely vessel traffic information.

6.2.2 National Services

The types of organizations that would be interested in the reporting services of the national office were identified in Section 2.2.3 of Chapter Two. It was estimated that the number of prospective national customers would range from 400 to 2,000, representing government, multinational corporation and other types of organizations involved with developing, regulating, monitoring, operating and reporting on various aspects of waterborne commerce in the U.S.

The products that would be provided to national and international clients would range from answering a telephone inquiry concerning the location of a particular vessel to a summary report of vessel movements at multiple ports. It is not within the scope of this feasibility study to definitize the particular products or services of the national system. It is possible to conclude with some confidence, however, that if an integrated national system of vessel reporting were to be created, the products of such a system would have significant added information value over and above the products being generated by the present fragmented, uncoordinated and incomplete system of vessel-traffic reporting.

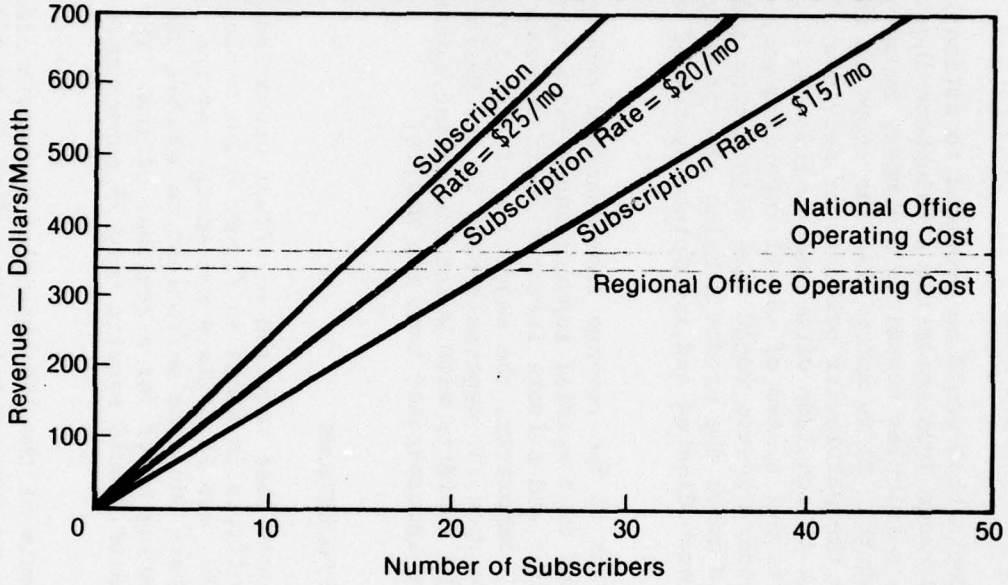
In addition to the revenue from standard reporting services, additional revenues from special reports and service contracts with selected federal agencies and private industry could increase the above figures considerably. Naturally, the magnitude of annual revenues of the National Office depends upon the aggressiveness of the marketing and promotional efforts and the rapidity with which new marine exchanges or regional offices can be incorporated into the NAVTIS.

6.3 REVENUE PROJECTIONS

The customer base required to offset operating costs of the regional and national offices is shown in Figure 8 for membership or subscription rates of 15, 20, and 25 dollars per month. At the lowest rate, approximately 20 members would be sufficient to support the vessel traffic computer operating costs for a regional office. The National Office, for the same rate, would require only 25 subscribers to cover operational costs.

On the basis of the 160 potential customers identified earlier, and the membership or subscription rates of 15 to 25 dollars per month, the annual revenues available to a regional office would be between $28,000 and $48,000 from services provided through the NAVTIS. At the national level, under the earlier developed assumption that the potential national client population ranges from 400 to 2000, the same membership or subscription rates would generate annual revenues between $72,000 and $600,000.

Figure 8. POTENTIAL REVENUE OF MARINE EXCHANGE REPORTING SYSTEM



As the number of national accounts grows, additional expenses for the national office will be incurred, but the revenues anticipated should not only cover these expenses but provide the incremental capital needed for the establishment of new regional offices. In addition, the new regional offices will be capable of generating revenue from local maritime companies and agencies, thus covering their expenses.

6.4 COST-REVENUE PROJECTIONS FOR IMPLEMENTATION ACTIVITIES

The activities described in Chapter Five were chronologically ordered for the purpose of estimating costs and revenues during the first two years associated with the implementation project. Figure 9 shows a tentative schedule of these activities.

6.4.1 Phase I

The first six months are devoted to organization and planning efforts by the regional marine exchanges forming the nucleus of the National Association. This same period would also include a Prototype System Demonstration culminating in a Technology Transfer Conference approximately 4 months after project initiation. (Appendix H shows a summary of a proposed plan for the development and implementation of the Prototype System Demonstration). Two occasions are identified within this period where all the participants would be required to meet. They are to (1) prepare a business plan -- and attend the Technology Transfer Conference (end of 4th month) and (2) form the National Association (end of 6th month). Support by the Maritime Administration is assumed during this period.

The second six months would be devoted to expanding the membership of the National Association to include additional regional offices, and marketing efforts by both regional and national groups to establish or increase the number of potential subscribers or customers. At the end of the first year, at the conclusion of Phase I, NAVTIS full time operations would be inaugurated.

A breakdown of estimated costs for the first phase of the implementation project is shown in Table 9. Direct costs associated with attendance at national meetings, legal fees for preparing a charter for the National Association, and membership and marketing activities were estimated to be $16,000. Indirect or labor costs associated with these activities were estimated to be approximately $11,000.

The combined cost of prototype NAVTIS system development/demonstration and technology transfer conference, estimated at $60,000, would constitute a relatively large expense for the embryonic National Association. It is recommended that MarAd absorb this cost to give the NAVTIS organization the required initial impetus.

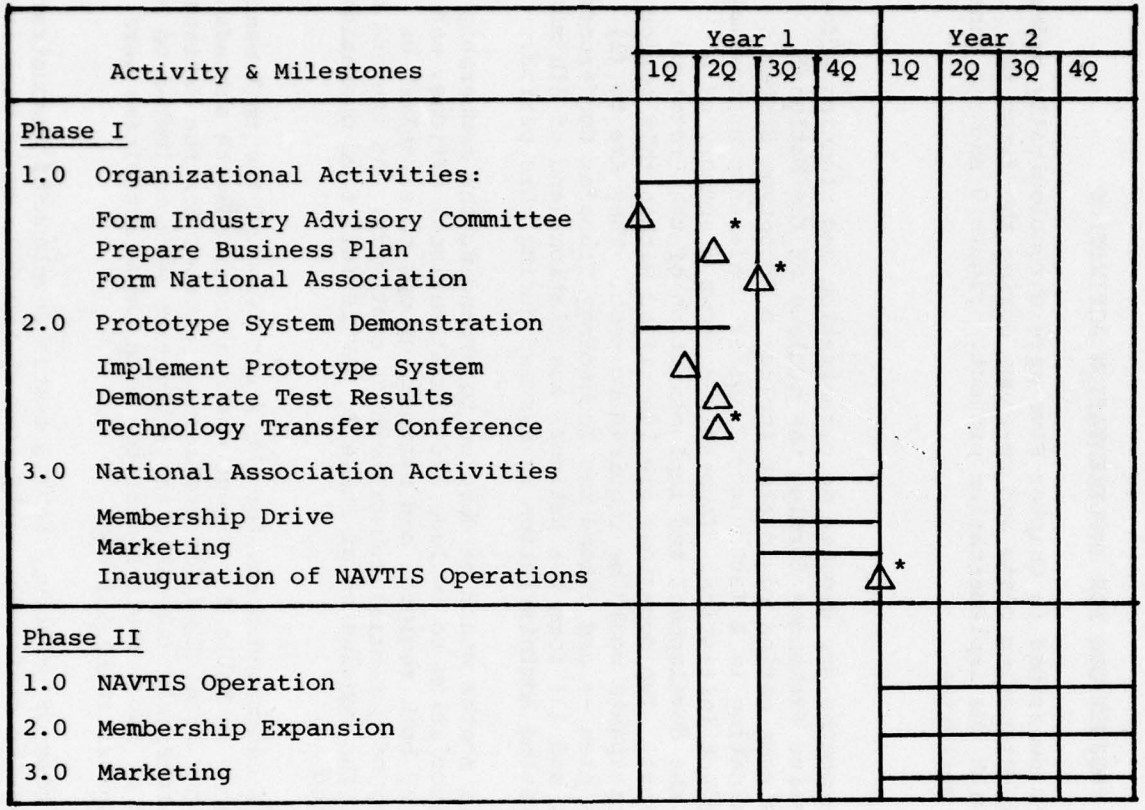


Figure 9. NAVTIS IMPLEMENTATION PLAN SCHEDULE

* Require national meeting of Committee and Association representatives

Table 9. ESTIMATED COSTS OF PHASE I IMPLEMENTATION ACTIVITIES

Activity	Costs	
	Direct	Indirect (Labor)
1. Organizational:		
Two National Meetings for Initial Candidates:		
Travel & Subsistence for 8 People Assuming 2 Days per Meeting	$ 7,000	$ 3,000[1] (20 Man Days)
Legal Fees for Association Charter	2,000	
2. Prototype System Development, Demonstration and Technology Transfer Conference	(60,000)[2]	3,000[3] (30 Man Days)
3. Membership & Marketing Activities		
Mailings (2,000 pieces @ 50¢/piece)	1,000	2,000[3] (20 Man Days)
Presentations (Marketing)	5,000	
Publicity, Telephone, etc.	1,000	3,000[1] (20 Man Days)
Total	$16,000	$11,000

1 Professional Personnel

2 Recommended to be absorbed by MarAd

3 Non-Professional Personnel

6.4.2 Phase II

Phase II encompasses a period of 12 months during which the NAVTIS operations are inaugurated and the system expands to a national level. A summary of the operating costs and revenues during Phase II, the first year of operation, is depicted in Figure 10 for three growth projections, a pessimistic, conservative and optimistic forecast of revenues. Table 10 shows the growth criteria for the three projections in terms of number of regional offices, number of customers per regional office, and number of customers for the national office at the beginning of NAVTIS operations and at the end of the first year. Surplus revenues shown in Figure 10b were compared to the implementation costs to determine how quickly start-up costs can be recovered. For the pessimistic case (Case I) surplus revenues for the first year would equal approximately $12,000. This would cover the direct costs of organizational and planning activities depicted in Table 9, but would not be sufficient to cover marketing expenses or the indirect (overhead) costs associated with activities of the Advisory Committee members. For the pessimistic case, a period of two years would be required to recover start-up costs. For the conservative case (Case II) surplus revenues for the first year would be about $38,000. This would appear to justify all of the implementation activities. The optimistic forecast (Case III) would yield approximately $85,000 in surplus revenues, more than enough to cover start-up costs, finance the installation and operational costs of data terminals in those port complexes not currently served by an exchange or participating in the NAVTIS, and accelerating the establishment of a full-time national office staff.

Table 10. GROWTH PROJECTIONS FOR FIRST YEAR OF NAVTIS OPERATIONS

Growth Item	Case I Pessimistic		Case II Conservative		Case III Optimistic	
	Start	End	Start	End	Start	End
Number Regional Offices	8	10	8	20	8	30
Number Customers/Regional Office	20	30	20	40	20	50
Number Customers for National Office	25	100	50	200	100	400

Figure 10a.

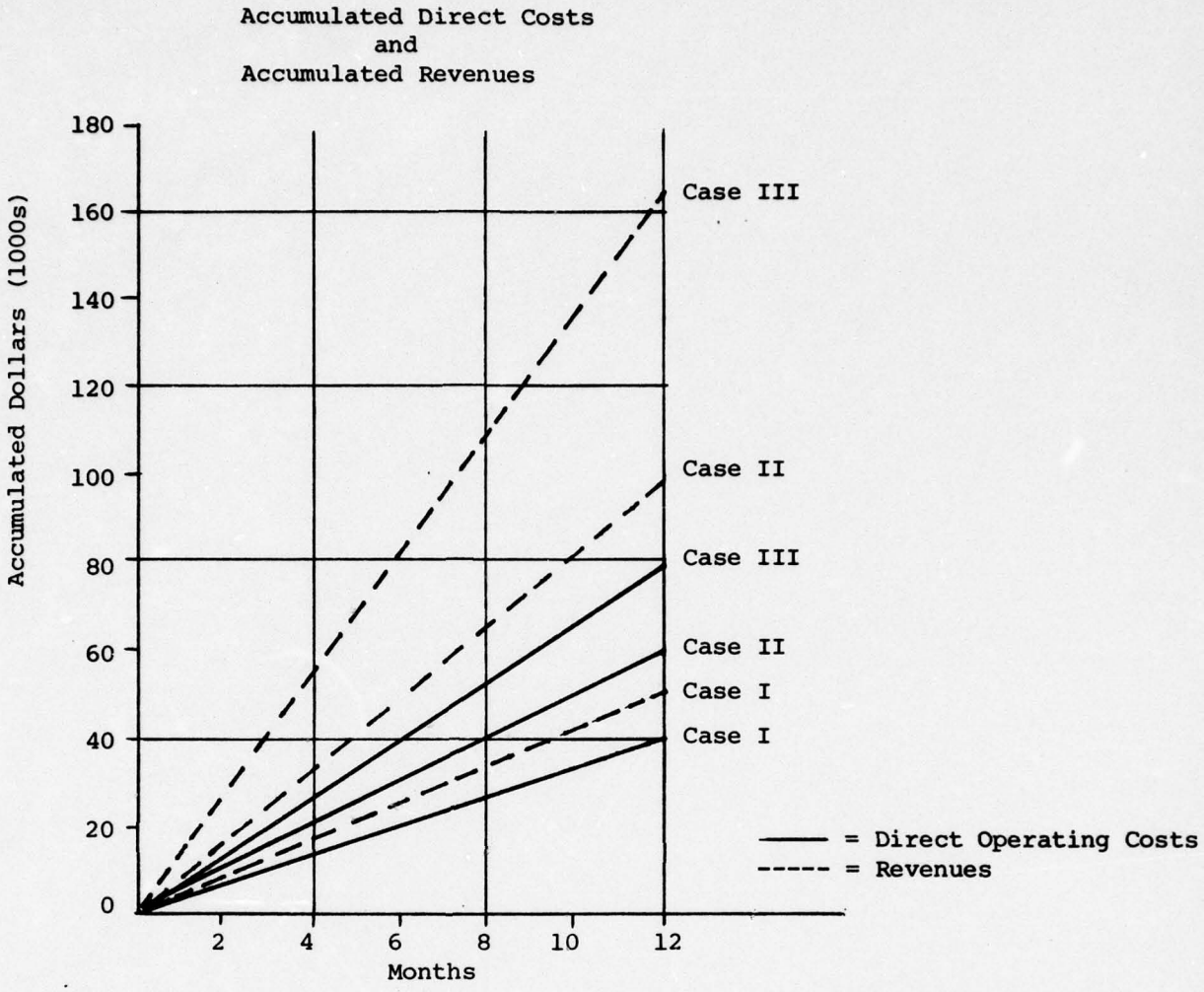


Figure 10b.

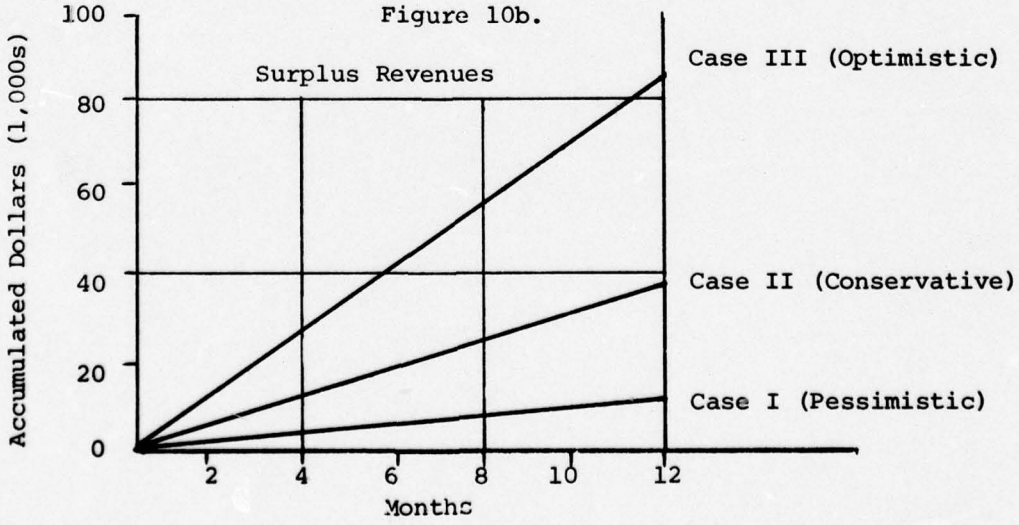


Figure 10. SUMMARY OF OPERATING COSTS AND REVENUES FOR SUBSCRIBER RATE OF $15/MONTH (Phase II Operations)

CHAPTER SEVEN

BENEFITS

The survey results and the associated development of vessel tracking requirements show that there are numerous benefits associated with the formation of a National Association of Marine Exchanges and the concurrent development of a computerized National Vessel-Traffic Information System. These benefits are listed below:

- Provides a data tabulation and processing service for the local exchanges, thus saving manpower and improving their efficiency (thereby lowering costs to their industry sponsors).

- Provides advance notice of ship berthing, alleviating possible facility conjestion and contributing to faster ship turnaround.

- Provides interport vessel-movement data to local exchange subscribers, thus improving ETA accuracy and allowing local exchange members to plan the use of their resources more efficiently and provide better service to their clients.

- Facilitates the development of standard procedures, reports, coding structures, etc., for vessel-movement reporting, thus increasing the usefulness of national vessel-traffic information.

- Provides the capability to interface with other automated data bases that are of benefit to the maritime community (vessel identification and characteristics files, vessel casualty files, etc.).

- Provides capability to influence Government policy on vessel-movement reporting requirements, potentially eleminating present redundant industry reporting of ETAs and ETDs to Government Agencies (e.g., USCG, Immigration, Customs, MarAd, etc.).

- Provides a national forum for the exchange of ideas and concepts in marine intelligence gathering and dissemination that can potentially advance the interests of the U.S. maritime community as a whole.

- Provides a new source of revenue from national clients requiring nationally aggregated information that cannot be satisfied on a local basis; the revenue thus produced can be used to provide additional services to the U.S. maritime industry.

- Provides a focal point for the ultimate development of an international data system on vessel movement and integration with other maritime data management systems (e.g., Lloyds, American Bureau of Ships, etc.).

The accumulated benefits listed above, coupled with the minimal technical and economic risks involved in the implementation of the NAVTIS concept provide a strong basis for the conclusions and recommendations presented in the following chapter.

CHAPTER EIGHT

CONCLUSIONS AND RECOMMENDATIONS

8.1 CONCLUSIONS

As presented in Chapter One of this report, the study goals focused on the feasibility of implementing an automated national system for gathering and disseminating vessel tracking information. The study goals could be framed in the question "Is a National Vessel-Traffic Information System serving the nation's maritime needs a feasible proposition from technical and economic standpoints?" The following conclusions respond to this question.

8.1.1 Technical Feasibility

The development of a National Vessel-Traffic Information System which coordinates and integrates vessel traffic data for most U. S. ports, is technically feasible. The preferred system configuration was determined to be the Specialized Value-Added-Network Concept. The teleprocessing hardware, software, and services required to implement a system of the required capacity are already available in forms that are more than sufficient to accommodate any foreseeable growth in such a system. Existing commercial computer time-sharing and telecommunications service offerings provide a very attractive system implementation alternative at very low technical risk and cost.

8.1.2 Economic Feasibility

The basic question to be answered in analyzing the economic feasibility of implementing a National Vessel-Traffic Information System is: "Are the expected revenues to be produced from operating the system sufficient to cover its costs?" An additional question is: "Is the system affordable -- i.e., if the system can support itself after it is in steady-state operation, can the initial implementation cost be recovered?"

The selection of the preferred system for the NAVTIS presents a very conservative approach for the development, implementation, and operation of the system. The capital investment costs are minimal for the establishment of the system, and a logical plan for growth as outlined in the implementation chapter (Chapter Six) is likely

to result in revenues that will exceed start-up and operational costs within one year after commencement of national operations. MarAd's financial support for the Prototype System Development and Demonstration Project and the Technology Transfer Conference would essentially eliminate any foreseeable economic risk for the initial sponsors of the system.

The prospects for the generation of surplus revenues after one year of operation are promising. This important consideration can provide the basis for subsequent expansion of the system to include data terminals for all of the major U.S. port complexes, and for establishment of a full-time staff for the national office.

8.2 RECOMMENDATIONS

It is recommended that appropriate actions be taken to make a National Vessel-Traffic Information System a reality. The following are specific recommendations:

- Existing marine reporting agencies should be invited to form an Industry Advisory Committee to perform the implementation functions described in Chapter Five.

- A prototype NAVTIS system should be implemented and demonstrated to the maritime industry. The demonstration should involve hands-on operation of NAVTIS data terminals by industry representatives. The demonstration should result in the collection of sufficient data to evaluate the performance of the system. It is recommended that MarAd sponsor this activity and provide the necessary funds.

- At the conclusion of the demonstration of a prototype NAVTIS, the Maritime Administration should sponsor a technology-transfer conference for members of Marine Exchanges and interested public groups to inform them of the results of the demonstration and to provide a forum for discussion of the technical and economic issues pertaining to the formation of a National Association of Marine Exchanges and the implementation of a NAVTIS.

APPENDIX A

LIST OF PORTS AND INDIVIDUALS SURVEYED

Area: Boston
Date of Survey: January 19, 1977
Contacts With:

John Halloran, Secretary/Treasurer & Manager, Maritime Association of Greater Boston
Capt. Arthur M. Knight, Commissioner of Pilots; President of Boston Towboat Co., & President, Mystic Steamship Corp.
A. Ross Pope, Vice President, Container Terminals Division, & George W. Trask, International Consultant, Patterson, Wylde & Co., Inc.
Earl A. Posey, Maurice H. Saval, Inc.
Capt. G. F. Ohlson, Boston Pilots
Thomas F. Moakley, Port Director, Massachusetts Port Authority

Area: New York
Date of Survey: January 20-21, 1977
Contacts With:

N. Nick Creton, Executive Director - The Maritime Association of the Port of New York (MAPONY)

Area: Philadelphia Port Area
Date of Survey: November 5, 1976
Contacts With:

William A. Harrison, Secretary - The Philadelphia Maritime Exchange
Leslie C. Krusen, Attorney - Krusen, Evans & Bryne
Fred Anderson, Partner - Taylor & Anderson Towing
Alfred Seavy, Manager - Montrose Laundry
Richard Venuti, Vice President - Philly Ship.
Martin Hoffman, Vice President - Allen Forwarding Co.
Willem H. VanRijnsoever, Salesman - Jake's Ship Chandler
Charles H. Crowe, Marine Engineer - Texaco, Inc.
Thomas Beck, Sr. Marine Rep. - Mobil Oil Corporation
George I. Lamb, Sales/Service Rep. - The Perolin Co., Inc.
Capt. Samuel M. Schellenger, President - Pilots' Assn. for Bay & River Delaware
Harry Fisher, Secretary - Philadelphia Port Corp.
Odd B. Sundquist, Assistant Vice President - J. A. McCarthy, Inc.

Area: Baltimore
Date of Survey: November 4, 1976
Contacts With:

Joseph A. Rafferty, Manager - Baltimore Maritime Exchange
Capt. Benjamin I. Beck, Jr., VP/General Manager - Curtis Bay Towing Co.
James V. Guthrie, President - The Cottman Co.
Paul F. Connor, Exec. V. P. - John S. Connor, Inc.
Charles F. Hughes, Jr., President - The Vane Brothers Co.

Area: Norfolk/Hampton Roads
Date of Survey: November 8, 1976
Contacts with:

Jack W. Mace, Executive Secretary - Hampton Roads Maritime Association
Capt. Richard L. Counselman, Pres., Capt. Robert Dozier, Vice Pres., and Capt. George Watkins, Board Member - Virginia Pilots Association
Braden Vandeventer, Sr. Partner - Vandeventer, Black, Meredith
Ian A. Hamilton, Vice President - Ramsay, Scarlett & Co., Inc.
Allen Peltz, Vice President - Peltz Bros., Inc.
James C. Page, President - The Hipage Co., Inc.

Area: Charleston, S. C. (including Port Royal & Georgetown)
Date of Survey: November 9, 1976
Contacts with:

J. Gregory Prior, Dir., Div. of Communications & Public Affairs - South Carolina Ports Authority
Capt. Sherrill Poulnot, Secretary, Capt. E. Randall Swan, Jr., Chief Dispatcher, John Stelling, Pres. - Charleston Branch Pilots Assn.
Gordon D. Schreck, Partner - Buist, Moore, Smythe & McGee
David C. Humphreys, District Director and Jack W. Hill, Dir., I&C, Division - U. S. Customs Service
Edward A. Inabinett, Vice President - Palmetto Shipping & Stevedoring Co.
M. H. Mikell, Vice President - Dickinson, Mickell & Comar, Inc.

Area: Savannah Port Area
Date of Survey: November 10, 1976
Contacts with:

(Mrs.) W. L. (Mary) Hann, Asst. to Dir. of Operations - Georgia Ports Authority
Capt. W. T. Brown, Master Pilot - Savannah Pilots Assn.
Revis E. Banks, Savannah Manager - Strachan Shipping Co.
Capt. Alexander D. Stewart, Treas. & Gen'l Manager - Atlantic Towing
Ernest Carter, President - D. J. Powers Co.
Gustave R. Dubus, III, Partner - Chamblee, Dubus & Sipple

Area: Jacksonville, Florida
Date of Survey: November 11, 1976
Contacts with:

James J. Scott, Managing Director & Ed A. Shaw, Dir. of Traffic - Jacksonville Port Authority
Jno G. McGiffin, President - McGiffin & Co., Inc.
Henry E. Sullivan, Jr., President - Sullivan & Son, Inc.
Jerry Yelvington, Dispatcher - St. Johns Pilots' Assn.

Area: Miami
Date of Survey: November 12, 1976
Contacts with:

Capt. John Fernandez, Chairman - Biscayne Bay Pilots Assn.
Douglas Gilette, Director, Promotion & Public Relations - Port of Miami

Area: Port Everglades, Florida
Date of Survey: November 12, 1976
Contacts with:

William C. Blood, Director of Marketing and Traffic and R. W. (Bob) Richards, Assistant Harbor Master - Port Everglades Authority
Captains M. A. Hairston, Robert I. Jackson and William Fagan, key man - Port Everglades Pilots Assn.

Area: Puerto Rico
Date of Survey: January 24-27, 1977
Contacts with:

Jose M. Pietri - Customs Broker, IATA Cargo Agent, Freight Forwarder
Miguel A. Burset, 2nd Vice President & Kenneth J. Gross, Asst. Vice President - Banco Popular de Puerto Rico
Luis Lizarribar - Vice President & General Manager, International Shipping Agency, Inc.
Celeste H. de Acosta - Independent Ocean Freight Forwarder, IATA Air Cargo Sales Agent
Rafael Rivera, Executive Director & Anibal L. Arsuaga, President - Puerto Rican Chamber of Commerce
Jose Ysern De La Cruz, Rates & Tariffs Technician & Artemis Segarra, Asst. Exec. Director for Planning & Operations - Puerto Rico Ports Authority
Jose Da Costa, President & Victor R. Carrion, Operations Manager - Carribe Shipping Co., Inc.

Area: Tampa/Port Manatee/St. Petersburg
Date of Survey: November 29, 1976
Contacts with:

Jean Rustin, Director of Traffic, Commerce & Development - Tampa Port Authority
Peter Alberti, Vice President - A. J. Arango, Inc.
K. I. McKay, Operations Mgr., - A. R. Savage & Son

Capt. V. W. Straigis, Tampa Bay Pilots
James H. Sanborn, Vice President - St. Philip Towing & Transportation Co., Inc.
A. F. Torres - Fillette, Green & Co. of Tampa

Area: Mobile, Alabama
Date of Survey: November 30, 1976
Contacts with:

Robert Hope, Director & General Manager, Ala. State Docks Dept.
E. G. "Buddy" Browning, Sales Dept., Ala. State Docks Dept.
Capt. W. K. Morgan, Chief Harbormaster, Ala. State Docks Dept.
William Black, Chief Engineer, Ala. State Docks Department
George D. Cunningham, N.D. Cunningham & Company, Inc.
E. Rob Leatherbury, Sr. Vice President - Ryan-Walsh Stevedoring Co., Inc.
L. H. Stuart, Jr., Vice President - Ryan-Walsh Stevedoring Co., Inc.
Tyler T. Boulo, President, Paul A. Boulo, Inc.
Capt. Douglas McColl, President, Mobile Pilot's Association
Capt. William E. Heath, Marine Safety Officer, U.S. Coast Guard

Area: New Orleans
Date of Survey: December 1, 1976
Contacts with:

Edward S. Reed, Exec. Port Director & Gen'l. Manager - Port of New Orleans
William S. Eckert, Deputy Port Director, Terminals & Cargo Handling, Port of New Orleans
Harvey C. Busch, Port Sales Manager, Port of New Orleans
C. J. Kirby, Port Statistician, Port of New Orleans
Capt. L.E.J. Andrews and Capt. Charles E. F. Arnoult, President, Crescent River Port Pilots Assn.
Daniel R. Meyers, Jr., President, Associated Branch Pilots
Clifford J. Smith, Director (and President-elect) (and Chairman, Gulf Associated Freight Conference), New Orleans Board of Trade
Ralph Rugan, Jr., Director (and Exec. V.P. Biehl & Company, Inc.), New Orleans Board of Trade
Murray M. Squires, Secretary/Treasurer, New Orleans Board of Trade
William St. Johns, President, W.R. Zanes & Co. of Louisiana, Inc.

Area: Houston/Galveston
Date of Survey: December 2, 1976
Contacts with:

J. R. Curtis, Director of Port Operations - Port of Houston
W. R. (Bill) Cook, Western Sales Manager - Port of Houston
J. W. Herton, Asst. to Director of Port Operations - Port of Houston
Alton Othold, Asst. to Director of Port Operations - Port of Houston
Rudy Julian, Chief Dispatcher, Houston Pilots Assn.
Carl D. Bond, Morgan's Point Maritime Services, Inc.

Area: Los Angeles (Wilmington, San Pedro, Long Beach, Terminal Island)
Date of Survey: January 26-27, 1977
Contacts with:

George Gutman - Operations Manager, Los Angeles Marine Exchange
Ralph Knerr - Operations Manager, Lilly Shipping Agencies
Duane Wallsworth - Vice President, Operations, General Steamship Co.
Jack Christopher - Sales Manager, & Chet Miller - Chief Investigator, Lillick, McHose and Charles
Lee Enlow - Manager, Henderson Ship Supply Co.
Don Crouthamel - Supervisor, Harbor Ship Supply Co.

Area: San Francisco, Oakland, Redwood City, Alameda, Richmond, Carquinez Straits, Upper San Pablo and Suisun Bays, Stockton and Sacramento
Date of Survey: January - February 1977
Contacts with:

Ron Duncan, Account Supervisor - AT&T Long Lines Division
Key Pryor, Communications Analysis - AT&T Long Lines Division
Douglas Cowle, Account Representative - AT&T Long Lines Division
Leo Wellington, Operations Manager - General Steamship Agencies
Reese B. Williams, Vice President, Operations - Western Tug and Barge
Donald Lynch, Chief Dispatcher - Shaver Transportation
Gus Gusdar, Operations Manager - Lilly Shipping Agencies
Randolph B. Jones, Dispatcher - San Francisco Bar Pilots
Jean Cordoba, Export Manager - Harper Robinson and Co.
Captain R. O'Connor, Operations Manager - Matson Navigation
John Poulin, General Manager - Harper Shipping
Don Draper, Sales Manager - West Coast Ship Chandlers

Area: Portland (Columbia River Range)
Date of Survey: October 21, 1976
Contacts with:

Richard Copeland, Manager & Chandler Smith, Asst. Mgr., - Merchants Exchange of Portland
CMDR Neil Nelson, USCG, C.O., VTS, Seattle
Ken Roberts, Sr. Atty. - Souther, Spaulding, Kinsey, Williamson and Schwabe
Garry J. Whyte, Asst. Director Terminal Operations - Port of Portland
Marvin R. Bolstad, Vice President - Lasco Shipping Co.
Ben Ellis, President - Geo. S. Bush Co.
George Shaver, President - Shaver Transportation Co.
Blake Hering, President - Atlas Steamship Co.

Area: Seattle (Puget Sound Range)
Date of Survey: October 22, 1976
Contacts with:

Clifford Muller, Dir., Systems & Data Processing, Richard Mohn, Asst. Gen'l. Manager
Martha Taylor, Vessel Info. - Port of Seattle
James Butler, VP & Gen'l. Manager, Jack Nalley, Sales Mgr., Northwest Marine Iron Works

Bob Buckingham, Pres., Thomas L. Ward, Mgr. Marine Dept. - Seaport Shipping
John Molsberry, Sec'y-Treas., Terrence B. Price, V.P. - Robert E. Landweer & Co., Inc.
Betty Hayner, Marine Exchange reporter and Martin O'Rourke, Dep. Exec. Vice President - Seattle Chamber of Commerce

Area: Duluth/Superior
Date of Survey: March 27, 1978 (Phone Survey March 20-24, 1978)
Contacts with:

Pual D. Pella, Port Director, Seaway Port Authority of Duluth
Davis Helberg, Manager, North Central Terminal Operators, Inc., Managing Agents - Seaway Port Authority of Duluth
Charles Hilleran, Guthrie-Hulner, Inc., Agents and Officer, Duluth Marine Association
Jim MacCarville, Port Director, Superior Board of Harbor Commissioners
Nick Baker, President, Superior Board of Harbor Commissioners

Area: Milwaukee
Date of Survey: March 28-29, 1978
Contacts with:

James L. Haskell, Deputy Municipal Port Director, Port of Milwaukee
Thomas T. Pfeil, Manager, Hansen Seaway Service, Ltd., and member of Port of Milwaukee Maritime Council

Area: Chicago
Date of Survey: March 30, 1978
Contacts with:

Al Hudson, Executive Director, United States Great Lakes Shipping Assn.
Captain Frank B. Miles, Deputy Chief Surveyor, National Cargo Bureau, Inc.
Edward J. Foskel, Acting Managing Director, Office of International Transportation, Illinois Department of Economic Development
Sam Schiphorst, President, InterShip, Inc.

Area: Port Huron, Michigan
Date of Survey: April 5, 1978
Contacts with:

Capt. H. E. MacDermid, Lakes Pilots Association, District 2
S. Parent, Lakes Pilots Association, District 2

Area: Detroit, Michigan
Date of Survey: April 5, 1978
Contacts with:

David Clark, Port Office Manager, Detroit Wayne County Port Commission

Area: Toledo, Ohio
Date of Survey: April 6, 1978

Contacts with:

Norman Fox, Director of Trade Development, Toledo Lucas County Port Authority
Richard Cory, Terminal Manager

Area: Lorain, Ohio
Date of Survey: April 4, 1978
Contacts with:

Jack Cain, President, Lorain Electronics Corporation
Ross Herrick, Consultant, Lorain Electronics Corporation

Area: Cleveland
Date of Survey: March 4, 1978
Contacts with:

Captain George R. Skuggen, Director, Great Lakes Pilotage Staff, U. S. Coast Guard - Ninth District
John Desmond, Traffic Manager, Cleveland - Cuyahoga County Port Authority
David Buchanan, Lake Carriers Association
Robert Clark, Great Lakes Pilotage Staff, U. S. Coast Guard
Ron Bodziony, Maritime Administration, Great Lakes Region
James R. Downing, Information Systems Project, U. S. Coast Guard

Survey Teams:

ARINC Research Corporation

T. McCarthy
R. Powell
M. Mitchell
R. Lamothe

San Francisco Marine Exchange

R. Langner
L. Silva

APPENDIX B

SAMPLE GREAT LAKES PILOT REPORT

GREAT LAKES PILOTAGE AUTHORITY, LTD.-- SOURCE FORM · G.L.P. 100-9-72

830198

VESSEL | FLAG | B CERT. ☐ NO B CERT. ☐ | INVOICE NO.

OVERALL LENGTH | EXTREME BREADTH | MOULDED DEPTH

AGENTS

TIME ORDERED FOR | DATE:

PLACE	ITINERARY	DATE AND TIME
	BOARDED	SAILED
	ARRIVED	SAILED
	ARRIVED	SAILED
	ARRIVED	SAILED
	ARRIVED	SAILED
	ARRIVED	DEBARKED

REMARKS (INCLUDING USE OF PILOT BOATS)

MASTER'S SIGNATURE | DATE

PILOT'S SIGNATURE | REG. NO.

OFFICE USE ONLY

PILOTAGE UNIT

CHARGES

DESIGNATED WATERS		
UNDESIGNATED WATERS		
DETENTION		
DELAY		
MOVAGE		
DOCKING		
UNDOCKING		
CANCELLATION		
SUB-TOTAL		
U.S. EXCHANGE		
CAN. EXCHANGE		
TOTAL		

DISPATCHING OFFICE:

HOME DISTRICT

APPENDIX C

LIST OF ADDITIONAL U. S. GOVERNMENT ORGANIZATIONS CONTACTED FOR SAMPLE SURVEY OF NATIONAL USERS

- Office of Management and Budget
  - Economics Statistics Branch, Balance of Payments
- Department of Agriculture
  - Statistical Reporting Service
    - International Programs
  - Economic Research Service
    - Economic Development Division
    - Foreign Demand and Competition Division
    - National Economics Analysis Division
  - Foreign Agricultural Service, IAC Programs
    - International Trade Policy
  - Marketing and Consumer Services
    - Transport and Warehouse Division
- Department of Commerce
  - U.S. Bureau of the Census
    - Foreign Trade Division
    - Data User Services Division
      - Users Services Staff
  - Bureau of Economic Analysis
    - Input-output Structures Branch
    - Regional Economic Analysis Division
      - Projections Branch
    - Office of International Economics
  - Domestic and International Business Administration
    - Transportation and Capital Equipment Division
      - Engines, Ship and Boat Equipment
      - Bureau of International Commerce
        - Strategic Planning Division
      - Bureau of International Economic Policy and Research
        - International Trade Analysis Staff
          - Foreign Trade Statistics
      - Office of International Finance and Investment
        - Transportation and Insurance

- Maritime Administration
  - Policy and Plans, Emergency Planning
  - Economic and Operational Analysis
  - Office of Subsidy Administration
    - Division of Trade Studies and Statistics
    - Ship and Trade Data
  - Office of Maritime Manpower
    - Shipyard, Seafaring and Longshore Employment Data
  - Office of Management Information Systems
- U.S. Department of Defense
  - Military Traffic Management Command
  - Navy
    - Naval Program Planning
      - Ship Management Information System
    - Naval Facilities Engineering Command
      - Transportation Statistics Analysis
    - Military Sea Lift Command
      - Statistics and Analysis Division
      - Command Information Systems Office
      - Operations
  - Army
    - U.S. Corps of Engineers
      - Waterborne Commerce Statistics Center
      - Inland Navigation System Analysis
      - Institute for Water Resources
      - Baltimore District Office
- U.S. Department of State
  - International Trade Policy
  - Office of International Trade
  - Office of Fuels and Energy
  - Office of Maritime Affairs
- U.S. Department of Transportation
  - Transportation Information Center
  - U.S. Coast Guard
    - Office of Merchant Marine Safety Merchant Vessel Inspection Division
    - AMVER Program
    - VTS Project Office

... Houston

... New Orleans

... Puget Sound

... San Francisco

. Saint Lawrence Seaway Development Administration

.. Trade Route Analysis

.. Operations

. Material Transportation Bureau

.. Office of Hazardous Materials Operations

. U.S. Department of the Treasury

. U.S. Customs Service

.. Vessel Entrances and Clearances

.. Director

.. Duty Assessment Division

. Export-Import Bank of the U.S.

. Systems Analysis and Coordination Department

. Federal Communications Commission

. Management Systems Division

. Federal Energy Administration

. National Energy Information Center

. Data and Analysis

. Federal Maritime Commission

. Office of Tariffs and Intermodalism

. Federal Reserve Board

. Balance of Payments, Division of International Finance

. U.S. International Trade Commission

. Office of Economic Research

. U.S. Water Resources Council

. National Assessment

. Canadian Vessel Information Network

APPENDIX D

LIST OF ADDITIONAL NATIONAL AND INTERNATIONAL CORPORATIONS CONTACTED FOR SAMPLE SURVEY OF NATIONAL USERS

National Industrial Traffic League, Washington, D. C.
Eckert Overseas Agency, Inc., New York, New York
Orient Overseas Container Line, Baltimore, Maryland
Sperry Marine System, New York, New York
All Transport, Inc., Baltimore, Maryland
Atlantic and Gulf Stevedores, Inc., Philadelphia, Pennsylvania
Midlantic National Bank, Newark, New Jersey
Wedemann and Godknecht, Inc., Baltimore, Maryland
Jane's-Franklin Watts Professional and Reference Division, New York, New York
Seatrain Lines, Inc., Port of New York Area and San Francisco
Barber Lines, Port of New York Area
All Transport, Inc., Port of New York Area
W. J. Byrnes and Company, Port of New York Area
Wolf D. Barth, Philadelphia, Pennsylvania
Pilots Association, Philadelphia, Pennsylvania
Samuel Shapiro and Company, Baltimore, Maryland
American Export Lines, Baltimore, Maryland
Baltimore Pilots Association, Baltimore, Maryland
Arrow Vifschultz, San Francisco, California
San Francisco Shipping Company, San Francisco, California
Harper-Robinson and Company, San Francisco, California

APPENDIX E

INTERPORT TRAFFIC MATHEMATICAL MODEL

ESTIMATING INTERPORT SHIPPING ACTIVITY AT U.S. PORTS 1975 - 1982

INTRODUCTION

One indicator of the potential demand for vessel intelligence and shipping traffic information is the number of one-way trips between U.S. ports involving vessels engaged in foreign trade. If it were possible to determine the number of such trips from any port, J, to any other port, K, it would also be possible to estimate the flow of vessel-related information between all port pairs and thereby define an information network which would minimize transmission costs.

Unfortunately, statistical summaries of shipping activity involving all U.S. port pairs do not exist. Therefore, in order to utilize the method, it is necessary to create an "algorithm" which predicts interport shipping activity based upon theoretical and heuristic considerations.

The purpose of this appendix is to describe such a predictive algorithm and present estimates of interport shipping activity for the years 1975 through 1982.

DESCRIPTION OF THE INTERPORT SHIPPING ACTIVITY ALGORITHM

We hypothesize that the number of vessels which travel from port complex J to port complex K during year Y is proportional to the fraction of all U.S.

arrivals during 1975 associated with complex J multiplied by the fraction of all U.S. arrivals during 1975 associated with complex K. The port complexes used in this analysis are identified in Table E-1.

$$N_{JK}(Y) = H(Y,J,K)\frac{A_J(75)A_K(75)}{\sum_J A_J(75)\sum_K A_K(75)} \qquad (1)$$

Here:

$N_{JK}(Y)$ = Number of one-way vessel trips from J to K during year Y

$A_J(75)$ = Total number of arrivals at J during year 1975 from all other ports in the world

$A_K(75)$ = Total number of arrivals at K during year 1975 from all other ports in the world

$\sum_J A_J(75)$ = Total number of arrivals at all U.S. ports during year 1975 from all other ports in the world

$\sum_K A_K(75) = \sum_J A_J(75)$

$H(Y,J,K)$ = A proportionality function to be defined

If equation (1) is to be valid, the proportionality function, $H(Y,J,K)$, must account for the fact that vessels engaged in foreign trade tend to minimize the coastwise steaming time at the U.S. end of foreign trade routes. In order to account for this tendency explicitly, we separate the proportionality variable into two parts:

$$H(Y,J,K) = N_o(J,Y)Q(J-K) \qquad (2)$$

Here, $Q(J-K)$ is a function of the steaming time between any two U.S. ports of call. Because U.S. coastal ports are nearly uniformly distributed along

TABLE E-1

PORT AGGREGATION PLAN

CODE, K	COMPLEX NAME	MAJOR PORTS INCLUDED IN COMPLEX
1	New England Coast	Portland Harbor, Portsmouth Harbor, Bucksport Harbor, Boston Harbor, Fall River Harbor, Providence, New Haven Harbor, New London Harbor, Bridgeport Harbor
2	New York	Port Chester Harbor; Hudson River Channel, New York and New Jersey; East River; Upper Bay; New York Harbor, New York and New Jersey; Newark Bay, New Jersey; New York and New Jersey channels
3	Philadelphia	Philadelphia, Camden, Wilmington, Trenton, Marcus Hook
4	Baltimore	Port of Baltimore only
5	Hampton Roads	Norfolk, Newport News
6	Wilmington, N.C.	Port of Wilmington and Morehead City Harbor
7	Charleston	Charleston Harbor and Georgetown Harbor
8	Savannah	Savannah Harbor, Brunswick Harbor
9	Jacksonville	Jacksonville Harbor, Canaveral Harbor
10	Miami	Miami Harbor, Port Everglades, Palm Beach Harbor
11	Tampa	Tampa Harbor only
12	San Juan	Commonwealth of Puerto Rico
13	Mobile	Mobile Harbor, Pascagoula Harbor
14	New Orleans	Port of New Orleans, Port of Baton Rouge
15	Sabine-Neches	Beaumont, Port Arthur
16	Houston-Galveston	Houston Ship Channel, Galveston Ship Channel
17	Corpus Christi	Corpus Christi, Freeport Harbor
18	Los Angeles-Long Beach	Ports of Los Angeles and Long Beach only
19	San Francisco Bay	San Francisco Harbor, Oakland Harbor, Richmond Harbor, Berkeley, San Pablo Bay, Suisun Bay Channel, Redwood City
20	Hawaii	Barber Point Harbor, Honolulu Harbor
21	Portland	Port of Portland, Oregon, Port of Longview, Port of Astoria, Port of Vancouver, Port of Coos Bay
22	Pudget Sound	Seattle Harbor, Tacoma Harbor, Port Angeles Harbor, Everett Harbor
23	Alaska	Anchorage, Skagway Harbor, Ketchikan Harbor

the three ocean coasts, the steaming between any two can be measured to a first approximation as the difference, J-K, between the number codes representing the port complexes (if we agree to number them sequentially).

The explicit formulation of Q(J-K) in terms of the "interport distance", J-K, must account for the fact that most ocean going vessels cannot hold more cargo than they can accumulate by visiting 1 to 7 ports. Furthermore, in order to minimize turnaround time, which increases in direct proportion to the number of ports visited, each vessel engaged in foreign trade tends to stop at as few ports as possible. Finally, in order to minimize steaming time, vessels tend to visit neighboring ports more often than non-neighboring ones. In consideration of these tendencies, we have formulated the following explicit relationship between Q and the interport distance:

$$Q(J-K) = a_J/(a_J + |J-K|) \qquad (3)$$

The relationship is graphed in Figure E1 for several values of "a_J". Our approach to determine the best value of "a_J" in equation 3 is discussed in the next section.

The function, $N_o(J,Y)$, in equation (2) is called the normalized growth function herein. It is formulated in a manner which satisfies certain "summing" constraints and incorporates available statistical data relating to the annual growth of U.S. shipping activity at each port complex of interest. We separate the various components in the following way:

$$N_o(J,Y) = N_o(J,75)[1 + G_J(Y-75)] \qquad (4)$$

Here, $N_o(J,75)$ is the base-year normalization value and $G_J(Y-75)$ is the percentage annual growth beyond 1975 in total shipping activity at port complex J.

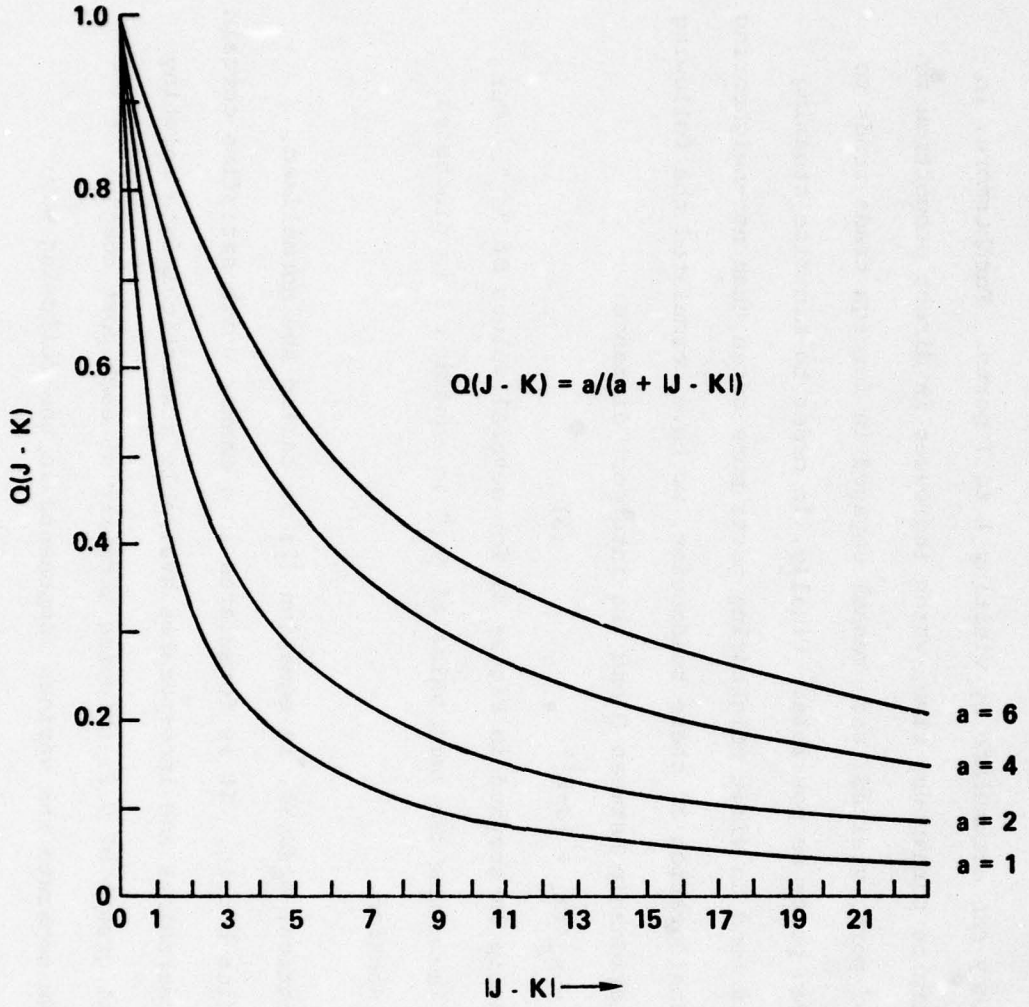


Figure E-1. **ALTERNATIVE INTERPORT TRIP MODIFIERS, Q(J - K)**

The "summing" constraint mentioned above stems from the fact that the total number of vessel arrivals at complex K during 1975 (a statistic which is available) must be equal to the number of vessels departing for K from all other ports in the world; i.e.

$$A_K(75) = \sum_J N_{JK}(75) \qquad (5)$$

Here, A_K is the total number of arrivals at K during 1975 and $N_{JK}(75)$ is given by equation (1) for Y=75. The result is a numerical solution for $N_o(J,75)$.

All equations offered above may be combined to obtain the final form of the algorithm. It is:

$$\frac{N_o(J,75)a_J[1 + G_J(Y-75)]A_J(75)A_K(75)}{(a_J + |J-K|)[\sum_K A_K(75)]^2} \qquad (6)$$

CALIBRATION OF THE ALGORITHM

The algorithm (equation 6) was calibrated using arrival and growth statistics shown in Figure E2 in conjunction with an analysis of actual vessel itineraries reported in the "N.Y. Journal of Commerce." The calibration procedure is summarized in this section.

Figure E2 was compiled from actual shipping activity statistics referenced in the figure. In using it to calibrate the algorithm it is necessary to make a judgment concerning which arrivals are to be counted in determining A_J and A_K. Because we are primarily interested in using the algorithm as a basis for estimating interport information requirements related to large, ocean-going vessels, we chose to count all self-propelled vessels with draft greater than 18 feet. Furthermore, we have chosen to

Figure E-2

SHIPPING ACTIVITY AT U.S. PORTS IN 23 AREAS

Port[1] Area or Complex	SHIPPING ACTIVITIES																					Historic[2] Growth per Decade (Ton Basis)
	Arrivals per Year[2]								Shipping Weight in Millions of Short Tons[2]						3 Months Sample (January, May, September) 1975 Average Value per Pound[3] (dollar per pound) (Customs)				IMPORT ACTIVITIES BY Service Type (Shipping Weight in million of lbs)			
	Draft > 18 ft.			Draft ≤ 18 ft.					Foreign		Domestic				Dry		Liquid					
	Self-Propelled			Self-Propelled			Not Self-Propelled				Coastwise		Internal R+S	Local					Tanker Service	Liner Service	Irregular Service	
	Dry	Liquid	Total	Dry	Liquid	Total	Dry	Liquid	Imports	Exports	Receipts	Shipments			Imports	Exports	Imports	Exports				
New England Coast	727	1945	2672	21243	3444	24687	204	3379	36.2	0.9	39.2	6.6	1.5	2.1	.25	.16	.04	.04	--	--	--	0.20
New York	3467	4321	12738	35070	16497	51557	29441	29270	48.9	6.7	33.0	21.7	20.0	47.0	.62	.91	.04	.61	--	--	--	0.13
Philadelphia	1837	519	2356	3971	200	4171	1749	3386	28.4	5.1	2.5	3.1	11.0	1.8	.05	.17	.04	.08	--	--	--	0.05
Baltimore	3131	369	3500	4398	338	4736	2715	4002	20.6	13.8	5.0	1.5	7.2	4.3	.08	.17	.03	.08	--	--	--	0.20
Hampton Roads	2967	528	3495	13474	1711	15185	6146	3194	7.5	43.3	2.3	0.5	11.8	1.4	.28	.06	.03	.18	--	--	--	0.26
Total North Atlantic Coast	17129	7682	24811	78136	22200	100336	40255	43231	141.6	69.8	82.0	33.4	51.5	56.6	.26	.29	.04	.20	236,307	20,356	90,661	0.17
Wilmington,N.C.	410	400	810	13412	12	13424	891	683	3.0	0.8	3.5	0.1	1.5	--	.10	.38	.03	.14	--	--	--	0.76
Charleston	992	263	1255	6327	1	6328	938	525	3.1	1.5	2.9	0.3	1.6	0.1	.19	.26	.03	--	--	--	--	0.49
Savannah	954	269	1223	1100	17	1117	1203	790	3.9	1.8	1.8	0.3	0.6	0.4	.15	.23	.03	.24	--	--	--	0.60
Jacksonville	885	505	1393	7212	28	7240	719	1779	4.8	1.6	6.1	0.8	2.7	0.2	.24	.09	.03	.03	--	--	--	0.37
Miami	1351	487	1838	11546	85	11631	452	879	3.6	1.1	7.8	1.5	0.9	--	.23	.53	.04	.31	--	--	--	0.61
San Juan	1624	171	1795	1465	113	1578	513	169	3.8	0.3	4.1	1.3	0.9	--	.23	.38	.03	--	--	--	--	0.41
Total South Atlantic Coast	6219	2095	8314	41062	256	41318	4716	4825	22.2	7.1	26.2	4.3	8.2	.7	.19	.31	.03	.12	56,155	4,249	11,547	0.54
Tampa	749	468	1217	2047	24	2071	1307	323	4.1	12.7	14.6	8.1	0.3	0.1	.05	.04	.03	.08	--	--	--	0.67
Mobile	845	359	1204	1965	55	2020	9293	4634	13.7	7.7	1.1	7.3	21.2	1.5	.02	.08	.04	.09	--	--	--	0.64
New Orleans	3618	11752	15370	4919	247	5166	40198	27617	24.2	43.8	4.7	21.3	101.4	4.9	.10	.13	.04	.07	--	--	--	1.17
Lake Charles-MEICHES	395	1105	1500	823	238	1061	4670	14140	14.2	6.2	3.7	17.1	16.6	0.5	.08	.07	.04	.05	--	--	--	0.01
Houston-Galveston	4875	3298	8173	3650	403	4053	7240	9822	19.1	21.1	3.4	20.7	21.6	3.7	.28	.19	.04	.11	--	--	--	0.39
Corpus-Christi	381	834	1215	3774	160	3934	722	4492	18.1	6.1	0.5	13.9	8.7	1.3	.01	.07	.04	.08	--	--	--	0.48
Total Gulf Coast	10863	17816	28679	17178	1127	18305	63430	61028	93.4	97.6	28.0	88.4	169.8	12.0	.09	.10	.04	.08	194,163	7,689	64,181	0.56
L.A.-Long Beach	2527	1059	3586	11109	263	11372	3322	2894	24.6	8.7	12.0	8.1	2.6	1.4	.49	.19	.04	.04	--	--	--	0.54
San Francisco Bay	2439	1042	3481	206	60	266	214	74	12.4	7.1	14.3	9.6	6.1	0.4	.45	.34	.05	.17	--	--	--	0.50
Hawaii	630	192	822	3478	8	3486	1511	107	4.6	--	4.8	3.6	--	--	.34	.44	.04	--	--	--	--	0.52
Total South Pacific Coast	5596	2293	7889	14793	331	15124	5047	3075	41.6	15.8	31.1	21.3	8.7	1.8	.43	.32	.04	.07	75,163	6,650	9,867	0.52
Portland	1583	355	1938	291	12	303	7798	2125	3.7	16.3	4.1	0.7	12.2	2.9	.11	.06	.05	.07	--	--	--	0.48
Puget Sound	1762	212	1974	40788	18	40806	6556	1991	6.2	8.3	2.0	2.2	9.4	2.1	.21	.07	.05	.07	--	--	--	0.29
Alaska	466	113	579	4799	25	4824	482	212	1.0	1.2	2.4	0.1	0.9	--	.24	.07	.05	.03	--	--	--	1.51
Total North Pacific Coast	3811	680	4491	45878	55	45933	14836	4328	10.9	25.8	8.5	3.0	22.5	5.0	.19	.07	.05	.06	15,580	2,685	17,237	0.76
Average/Port Area	1896	1329	3225	8567	1042	9609	5577	5065	13.5	9.4	7.6	6.5	11.3	3.3	.21	.22	.04	.11	25,103	1,810	8,413	.49

NOTES: (1) See Table A2 to identify all ports that are aggregated in each Port Area.
(2) Waterborne Commerce of the U.S., 1975 Department of the Army U.S. Corps of Engineers.
(3) U.S. Waterborne Exports and General Imports FT985-75-2, U.S. Department of Commerce.

give equal weight to all such vessels, independent of cargo, because certain important information needs are independent of the cargo hauled (e.g., pilotage, bunkering, anchorage availability).

Another aspect of the calibration deserves comment. Equation 6 allows one to estimate the number of vessels traveling from port J to port K=J. For example, it estimates the number of vessels traveling from New Orleans (J=14) to New Orleans (K=14). How does one interpret this estimate? The answer is that N_{JK} for J=K represents the number of vessels which either:

a. travel from one part of the Jth complex (e.g. New Orleans) to another part of the same complex without stopping at ports outside the complex, or
b. depart from the Jth complex (e.g. New Orleans) to foreign ports and return without stopping at U.S. ports outside the Jth complex.

As can be seen from Figure B1 for $|J-K|=o$; masters, agents and owners prefer the J=K alternative over any $J \neq K$ alternative by a considerable margin.*

The growth factor, $G_J(Y-75)$, in equation 6 was calculated by projecting the historical growth in shipping activity (ton basis) into the future. The historical growth derived from statistics covering the decade 1966-1975 is given in Figure E? for each port complex.

*This preference has considerable impact on the viability of any multi-port vessel intelligence and shipping traffic information system, not the least of which is the conclusion that the perceived benefits of multi-port information exchange are higher between foreign and domestic ports than between domestic ports. Another conclusion is that ports located near very large ports (i.e., A_JLarge) probably benefit more from the proximity than they lose from competition for the common hinterland.

The constant "a_J" in equation 6 was determined in the following way. First, we "observed" the actual number of trips between all port complexes J=1 to J-23 and two destinations: New York (Figure B3) and New Orleans (Figure B4), as reported in the Journal of Commerce. Next, we selected a hypothetical value for "a_J" and used the algorithm to estimate trips over the same period. We continued selecting values of "a_J" until the Journal of Commerce sample and the algorithm estimates became approximately the same within the limits of sampling error at the 99% confidence level. The final comparison is shown in Figures E3 and E4.

RESULTS: INTERPORT SHIPPING ACTIVITY AT U.S. PORTS

The results of exercising the algorithm for the years 1975 through 1982 are presented in Figure E5.

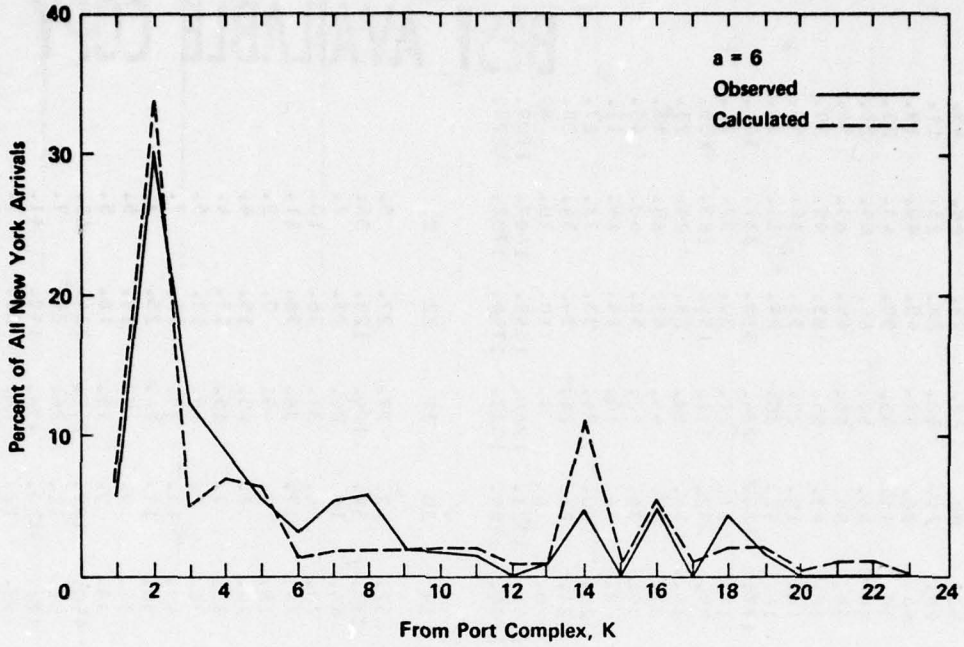


Figure E-3. OBSERVED VS CALCULATED VESSEL TRAFFIC FROM PORT COMPLEXES, K, TO NEW YORK

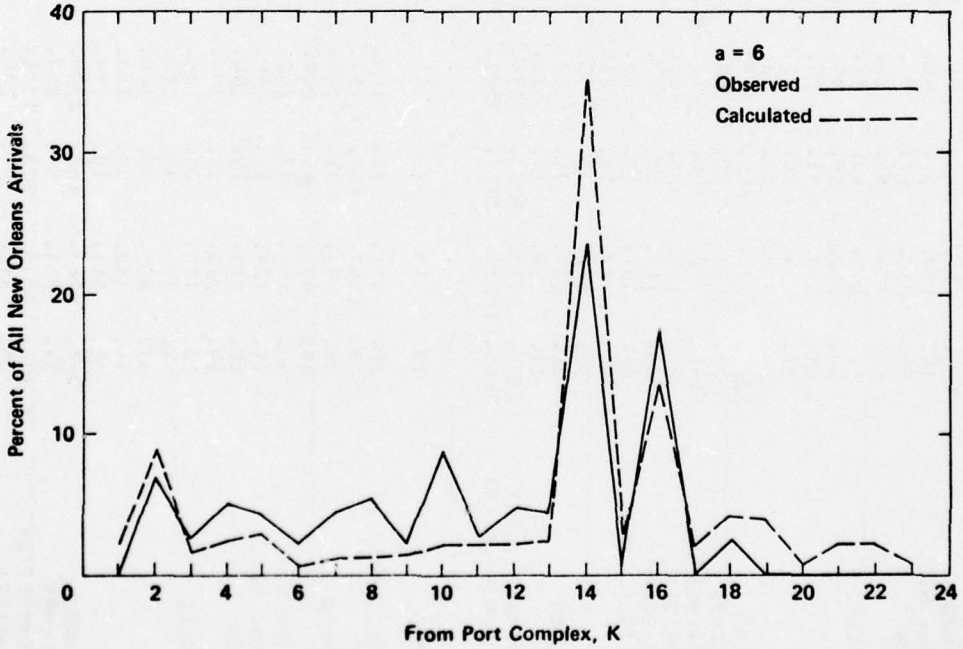


Figure E-4. OBSERVED VS CALCULATED VESSEL TRAFFIC FROM PORT COMPLEXES, K, TO NEW ORLEANS

Figure E-5

PREDICTED INTERPORT TRIPS
PER YEAR (ONE WAY)
1975

	FROM J \ TO K	1	2	3	4	5	6	7	8	9	10	11	12
1	NEW ENGLAND COAST	214.	878.	141.	187.	168.	35.	50.	45.	48.	59.	54.	29.
2	NEW YORK	807.	4504.	711.	924.	821.	171.	241.	215.	226.	277.	253.	135.
3	PHILADELPHIA	131.	717.	154.	196.	172.	35.	49.	44.	46.	56.	50.	27.
4	BALTIMORE	174.	936.	197.	341.	292.	59.	82.	72.	74.	90.	81.	42.
5	HAMPTON ROADS	158.	841.	174.	296.	345.	68.	93.	80.	82.	99.	88.	45.
6	WILMINGTON, N.C.	34.	179.	37.	61.	70.	19.	25.	21.	22.	26.	23.	11.
7	CHARLESTON	49.	256.	52.	86.	96.	25.	46.	38.	38.	45.	40.	19.
8	SAVANNAH	44.	230.	46.	76.	84.	22.	39.	44.	43.	50.	43.	20.
9	JACKSONVILLE	47.	242.	48.	78.	86.	22.	39.	43.	57.	65.	55.	25.
10	MIAMI	58.	297.	59.	95.	103.	26.	45.	50.	65.	99.	83.	36.
11	SAN JUAN	53.	270.	53.	85.	92.	23.	40.	43.	55.	83.	95.	39.
12	TAMPA	27.	134.	26.	41.	43.	11.	18.	19.	23.	33.	36.	40.
13	MOBILE	24.	120.	23.	36.	39.	9.	16.	16.	20.	29.	31.	33.
14	NEW ORLEANS	273.	1371.	265.	415.	437.	107.	177.	184.	224.	318.	337.	342.
15	SABINE-NECHES	27.	133.	26.	40.	42.	10.	17.	17.	21.	30.	32.	31.
16	HOUSTON-GALVESTON	142.	709.	136.	212.	223.	54.	89.	92.	111.	156.	163.	155.
17	CORPUS-CHRISTI	22.	108.	21.	32.	34.	8.	13.	14.	17.	23.	24.	23.
18	L.A.-LONG BEACH	63.	313.	60.	92.	95.	23.	37.	37.	44.	61.	63.	53.
19	SAN FRANCISCO BAY	61.	301.	57.	88.	91.	22.	35.	36.	42.	58.	60.	49.
20	HAWAII	15.	72.	14.	21.	22.	5.	8.	8.	10.	14.	14.	12.
21	PORTLAND	35.	172.	33.	50.	52.	12.	20.	20.	24.	33.	33.	27.
22	PUGET SOUND	36.	179.	34.	52.	54.	13.	21.	21.	24.	34.	34.	28.
23	ALASKA	11.	54.	10.	16.	16.	4.	6.	6.	7.	10.	10.	8.
	SUM (USA PORTS),S(K)	2291.	8512.	2223.	3179.	3132.	764.	1160.	1121.	1266.	1649.	1607.	1189.
	SUM (ALL PORTS),S'(K)	2505.	13016.	2377.	3520.	3477.	783.	1206.	1165.	1323.	1748.	1702.	1229.

	FROM J \ TO K	13	14	15	16	17	18	19	20	21	22	23
1	NEW ENGLAND COAST	28.	336.	31.	164.	23.	56.	52.	12.	27.	27.	8.
2	NEW YORK	127.	1547.	144.	751.	107.	253.	237.	54.	124.	123.	35.
3	PHILADELPHIA	25.	302.	28.	146.	21.	49.	46.	10.	24.	23.	7.
4	BALTIMORE	39.	474.	44.	228.	32.	75.	70.	16.	37.	36.	10.
5	HAMPTON ROADS	42.	505.	47.	242.	34.	79.	74.	17.	38.	38.	11.
6	WILMINGTON, N.C.	11.	127.	12.	60.	9.	19.	18.	4.	9.	9.	3.
7	CHARLESTON	18.	211.	19.	100.	14.	32.	29.	7.	15.	15.	4.
8	SAVANNAH	19.	221.	20.	104.	15.	32.	30.	7.	15.	15.	4.
9	JACKSONVILLE	23.	270.	25.	126.	18.	38.	36.	8.	18.	18.	5.
10	MIAMI	33.	384.	35.	177.	25.	53.	49.	11.	25.	25.	7.
11	SAN JUAN	35.	406.	37.	185.	26.	54.	50.	11.	26.	25.	7.
12	TAMPA	34.	382.	33.	163.	22.	42.	38.	9.	19.	19.	5.
13	MOBILE	38.	411.	35.	170.	23.	42.	38.	9.	19.	18.	5.
14	NEW ORLEANS	387.	5767.	482.	2300.	304.	538.	490.	109.	242.	234.	65.
15	SABINE-NECHES	34.	501.	57.	267.	35.	58.	53.	12.	26.	25.	7.
16	HOUSTON-GALVESTON	170.	2448.	273.	1736.	221.	352.	317.	70.	154.	148.	41.
17	CORPUS-CHRISTI	25.	348.	38.	238.	41.	61.	55.	12.	26.	25.	7.
18	L.A.-LONG BEACH	55.	753.	79.	462.	74.	439.	365.	75.	158.	145.	39.
19	SAN FRANCISCO BAY	52.	701.	73.	426.	68.	374.	423.	86.	177.	160.	42.
20	HAWAII	12.	163.	17.	98.	16.	81.	90.	25.	50.	45.	12.
21	PORTLAND	28.	378.	39.	226.	36.	176.	193.	52.	143.	125.	32.
22	PUGET SOUND	29.	384.	40.	228.	36.	170.	184.	49.	131.	156.	39.
23	ALASKA	9.	114.	12.	68.	11.	48.	52.	14.	36.	42.	14.
	SUM (USA PORTS),S(K)	1235.	11366.	1563.	6929.	1170.	2682.	2566.	654.	1396.	1340.	395.
	SUM (ALL PORTS),S'(K)	1273.	17133.	1620.	8665.	1211.	3121.	2989.	679.	1539.	1496.	409.

Figure E-5, Contd.

PREDICTED INTERPORT TRIPS
PER YEAR (ONE WAY)
1976

	FROM J \ TO K	1	2	3	4	5	6	7	8	9	10	11	12
1	NEW ENGLAND COAST	218.	895.	144.	191.	171.	36.	51.	46.	49.	60.	55.	30.
2	NEW YORK	817.	4562.	720.	937.	831.	173.	244.	218.	229.	281.	256.	137.
3	PHILADELPHIA	132.	721.	155.	197.	172.	36.	50.	44.	46.	56.	51.	27.
4	BALTIMORE	177.	954.	201.	348.	298.	60.	83.	73.	76.	91.	82.	43.
5	HAMPTON ROADS	162.	862.	179.	303.	354.	70.	95.	82.	85.	101.	91.	46.
6	WILMINGTON, N.C.	37.	193.	40.	66.	75.	20.	27.	23.	23.	28.	25.	12.
7	CHARLESTON	51.	268.	54.	90.	101.	27.	48.	40.	40.	47.	41.	20.
8	SAVANNAH	47.	244.	49.	80.	89.	23.	41.	47.	46.	53.	46.	21.
9	JACKSONVILLE	49.	251.	50.	81.	89.	23.	40.	45.	59.	67.	57.	26.
10	MIAMI	61.	315.	62.	100.	109.	28.	48.	53.	69.	106.	88.	38.
11	SAN JUAN	55.	282.	56.	89.	96.	24.	41.	45.	58.	87.	99.	40.
12	TAMPA	28.	143.	28.	44.	46.	11.	19.	20.	25.	35.	38.	43.
13	MOBILE	25.	127.	25.	39.	41.	10.	17.	17.	21.	31.	33.	35.
14	NEW ORLEANS	305.	1531.	296.	463.	488.	120.	197.	205.	250.	356.	376.	383.
15	SABINE-NECHES	27.	133.	26.	40.	42.	10.	17.	17.	21.	30.	32.	31.
16	HOUSTON-GALVESTON	147.	736.	142.	221.	231.	56.	92.	95.	115.	162.	170.	161.
17	CORPUS-CHRISTI	23.	114.	22.	34.	36.	9.	14.	14.	17.	25.	26.	24.
18	L.A.-LONG BEACH	67.	330.	63.	97.	100.	24.	39.	39.	47.	65.	66.	55.
19	SAN FRANCISCO BAY	64.	316.	60.	92.	96.	23.	37.	37.	44.	61.	62.	52.
20	HAWAII	15.	76.	14.	22.	23.	5.	9.	9.	11.	15.	15.	12.
21	PORTLAND	36.	180.	34.	52.	54.	13.	21.	21.	25.	34.	35.	28.
22	PUDGET SOUND	37.	184.	35.	53.	55.	13.	21.	21.	25.	35.	35.	28.
23	ALASKA	13.	63.	12.	18.	19.	4.	7.	7.	9.	12.	12.	9.
	SUM (USA PORTS),S(K)	2375.	8918.	2312.	3309.	3262.	798.	1210.	1171.	1331.	1732.	1692.	1258.
	SUM (ALL PORTS),S'(K)	2593.	13480.	2467.	3657.	3616.	818.	1258.	1218.	1390.	1838.	1791.	1301.

	FROM J \ TO K	13	14	15	16	17	18	19	20	21	22	23
1	NEW ENGLAND COAST	28.	342.	32.	167.	24.	57.	53.	12.	28.	28.	8.
2	NEW YORK	129.	1567.	146.	761.	108.	256.	240.	55.	126.	124.	35.
3	PHILADELPHIA	25.	303.	28.	147.	21.	49.	46.	10.	24.	24.	7.
4	BALTIMORE	40.	483.	45.	232.	33.	76.	72.	16.	37.	37.	10.
5	HAMPTON ROADS	43.	518.	48.	248.	35.	81.	75.	17.	39.	39.	11.
6	WILMINGTON, N.C.	11.	137.	13.	65.	9.	21.	19.	4.	10.	10.	3.
7	CHARLESTON	19.	222.	20.	105.	15.	33.	31.	7.	16.	16.	4.
8	SAVANNAH	20.	234.	21.	110.	15.	34.	32.	7.	16.	16.	5.
9	JACKSONVILLE	24.	280.	26.	130.	18.	40.	37.	8.	19.	19.	5.
10	MIAMI	35.	407.	37.	188.	26.	56.	52.	12.	27.	26.	7.
11	SAN JUAN	36.	423.	38.	193.	27.	56.	52.	12.	27.	26.	7.
12	TAMPA	37.	408.	35.	173.	23.	45.	41.	9.	21.	20.	6.
13	MOBILE	40.	438.	37.	181.	24.	45.	41.	9.	20.	20.	5.
14	NEW ORLEANS	433.	6442.	539.	2569.	339.	601.	547.	122.	271.	261.	73.
15	SABINE-NECHES	34.	502.	57.	267.	35.	59.	53.	12.	26.	25.	7.
16	HOUSTON-GALVESTON	177.	2544.	284.	1304.	230.	365.	329.	73.	160.	154.	43.
17	CORPUS-CHRISTI	26.	364.	40.	249.	43.	64.	57.	13.	28.	26.	7.
18	L.A.-LONG BEACH	58.	793.	83.	487.	78.	463.	385.	80.	167.	153.	41.
19	SAN FRANCISCO BAY	54.	736.	77.	447.	72.	392.	444.	90.	186.	168.	44.
20	HAWAII	13.	172.	18.	103.	16.	85.	94.	26.	53.	47.	12.
21	PORTLAND	29.	396.	41.	237.	38.	185.	202.	55.	150.	131.	34.
22	PUDGET SOUND	29.	395.	41.	235.	37.	175.	189.	50.	135.	161.	40.
23	ALASKA	10.	132.	14.	78.	12.	56.	60.	16.	41.	48.	17.
	SUM (USA PORTS),S(K)	1310.	11796.	1663.	7372.	1235.	2831.	2707.	689.	1477.	1418.	414.
	SUM (ALL PORTS),S'(K)	1350.	18238.	1720.	9176.	1278.	3294.	3151.	715.	1627.	1579.	431.

Figure E-5, Contd.

PREDICTED INTERPORT TRIPS
PER YEAR (ONE WAY)
1977

	FROM J	TO K 1	2	3	4	5	6	7	8	9	10	11	12
1	NEW ENGLAND COAST	223.	913.	147.	194.	175.	37.	52.	47.	50.	61.	56.	30.
2	NEW YORK	828.	4621.	730.	949.	842.	176.	247.	221.	232.	285.	259.	139.
3	PHILADELPHIA	132.	724.	156.	198.	173.	36.	50.	44.	46.	56.	51.	27.
4	BALTIMORE	181.	973.	205.	355.	304.	62.	85.	74.	77.	93.	84.	44.
5	HAMPTON ROADS	166.	884.	183.	311.	363.	72.	98.	85.	87.	104.	93.	47.
6	WILMINGTON, N.C.	39.	207.	42.	71.	81.	22.	29.	25.	25.	30.	26.	13.
7	CHARLESTON	54.	281.	57.	94.	106.	28.	51.	42.	42.	49.	43.	21.
8	SAVANNAH	50.	258.	52.	85.	94.	24.	43.	49.	48.	56.	48.	23.
9	JACKSONVILLE	50.	260.	52.	84.	92.	24.	41.	46.	61.	69.	59.	27.
10	MIAMI	65.	333.	66.	106.	116.	30.	51.	56.	72.	112.	93.	40.
11	SAN JUAN	57.	293.	58.	92.	100.	25.	43.	47.	60.	90.	103.	42.
12	TAMPA	30.	152.	30.	46.	49.	12.	20.	21.	26.	38.	40.	46.
13	MOBILE	27.	135.	26.	41.	43.	11.	18.	18.	23.	32.	34.	37.
14	NEW ORLEANS	337.	1692.	327.	512.	539.	132.	218.	227.	276.	393.	416.	423.
15	SABINE-NECHES	27.	133.	26.	40.	42.	10.	17.	17.	21.	30.	32.	31.
16	HOUSTON-GALVESTON	153.	764.	147.	229.	240.	59.	96.	99.	120.	168.	176.	167.
17	CORPUS-CHRISTI	24.	119.	23.	36.	37.	9.	15.	15.	18.	26.	27.	25.
18	L.A.-LONG BEACH	70.	347.	66.	102.	105.	25.	41.	41.	49.	68.	70.	58.
19	SAN FRANCISCO BAY	67.	331.	63.	97.	100.	24.	39.	39.	47.	64.	65.	54.
20	HAWAII	16.	80.	15.	23.	24.	6.	9.	9.	11.	15.	16.	13.
21	PORTLAND	38.	188.	36.	55.	57.	14.	22.	22.	26.	36.	36.	30.
22	PUGET SOUND	38.	189.	36.	55.	57.	14.	22.	22.	26.	36.	36.	29.
23	ALASKA	14.	71.	13.	21.	21.	5.	8.	8.	10.	13.	13.	11.
	SUM (USA PORTS),S(K)	2463.	9327.	2400.	3441.	3397.	835.	1264.	1225.	1392.	1812.	1773.	1331.
	SUM (ALL PORTS),S*(K)	2686.	13948.	2556.	3796.	3760.	857.	1315.	1274.	1453.	1924.	1876.	1377.

	FROM J	TO K 13	14	15	16	17	18	19	20	21	22	23
1	NEW ENGLAND COAST	29.	349.	33.	170.	24.	58.	54.	12.	28.	28.	8.
2	NEW YORK	131.	1587.	148.	770.	110.	259.	243.	56.	127.	126.	36.
3	PHILADELPHIA	25.	305.	28.	147.	21.	49.	46.	11.	24.	24.	7.
4	BALTIMORE	41.	492.	46.	237.	34.	78.	73.	17.	38.	38.	11.
5	HAMPTON ROADS	44.	531.	49.	254.	36.	83.	77.	18.	40.	40.	11.
6	WILMINGTON, N.C.	12.	146.	13.	70.	10.	22.	21.	5.	11.	11.	3.
7	CHARLESTON	19.	232.	21.	110.	15.	35.	32.	7.	17.	16.	5.
8	SAVANNAH	21.	243.	23.	116.	16.	36.	34.	8.	17.	17.	5.
9	JACKSONVILLE	24.	290.	26.	135.	19.	41.	38.	9.	20.	19.	5.
10	MIAMI	37.	431.	39.	198.	28.	59.	55.	12.	28.	28.	8.
11	SAN JUAN	38.	440.	40.	200.	28.	59.	54.	12.	28.	27.	8.
12	TAMPA	39.	433.	38.	184.	25.	48.	44.	10.	22.	21.	6.
13	MOBILE	42.	464.	40.	192.	26.	47.	43.	10.	22.	21.	6.
14	NEW ORLEANS	478.	7117.	595.	2838.	375.	664.	604.	134.	299.	289.	80.
15	SABINE-NECHES	34.	502.	57.	267.	35.	59.	53.	12.	26.	25.	7.
16	HOUSTON-GALVESTON	184.	2639.	294.	1871.	238.	379.	342.	75.	166.	160.	44.
17	CORPUS-CHRISTI	27.	381.	42.	261.	45.	67.	60.	13.	29.	28.	8.
18	L.A.-LONG BEACH	61.	834.	87.	512.	82.	486.	405.	84.	175.	161.	43.
19	SAN FRANCISCO BAY	57.	771.	80.	468.	75.	411.	465.	94.	194.	176.	46.
20	HAWAII	13.	180.	19.	108.	17.	89.	99.	27.	55.	49.	13.
21	PORTLAND	31.	415.	43.	248.	39.	193.	211.	57.	157.	137.	35.
22	PUGET SOUND	30.	406.	42.	241.	38.	180.	194.	52.	139.	165.	42.
23	ALASKA	11.	149.	15.	88.	14.	63.	67.	18.	47.	55.	19.
	SUM (USA PORTS),S(K)	1380.	12225.	1761.	7814.	1305.	2979.	2849.	726.	1552.	1496.	437.
	SUM (ALL PORTS),S*(K)	1428.	19342.	1818.	9685.	1350.	3465.	3314.	753.	1709.	1661.	456.

Figure E-5, Contd.

PREDICTED INTERPORT TRIPS
PER YEAR (ONE WAY)
1978

	FROM J	TO K 1	2	3	4	5	6	7	8	9	10	11	12
1	NEW ENGLAND COAST	227.	930.	150.	198.	178.	38.	53.	48.	51.	62.	57.	31.
2	NEW YORK	838.	4679.	739.	961.	853.	178.	250.	224.	235.	288.	263.	141.
3	PHILADELPHIA	133.	728.	156.	199.	174.	36.	50.	44.	46.	56.	51.	27.
4	BALTIMORE	184.	992.	209.	362.	310.	63.	87.	76.	79.	95.	86.	44.
5	HAMPTON ROADS	170.	906.	188.	319.	371.	74.	100.	87.	89.	107.	95.	49.
6	WILMINGTON, N.C.	42.	220.	45.	75.	86.	23.	31.	26.	27.	32.	28.	14.
7	CHARLESTON	56.	293.	59.	98.	110.	29.	53.	44.	44.	52.	45.	22.
8	SAVANNAH	52.	271.	55.	89.	99.	26.	46.	52.	51.	59.	51.	24.
9	JACKSONVILLE	52.	269.	54.	87.	96.	25.	43.	48.	64.	72.	61.	28.
10	MIAMI	68.	351.	70.	112.	122.	31.	54.	59.	76.	118.	98.	42.
11	SAN JUAN	59.	304.	60.	96.	104.	26.	45.	48.	62.	94.	107.	43.
12	TAMPA	32.	161.	31.	49.	52.	13.	21.	22.	28.	40.	43.	48.
13	MOBILE	28.	143.	28.	43.	46.	11.	19.	20.	24.	34.	36.	39.
14	NEW ORLEANS	369.	1852.	358.	560.	591.	145.	239.	248.	303.	430.	455.	463.
15	SABINE-NECHES	27.	133.	26.	40.	42.	10.	17.	18.	21.	30.	32.	31.
16	HOUSTON-GALVESTON	158.	791.	152.	237.	249.	61.	99.	102.	124.	174.	183.	173.
17	CORPUS-CHRISTI	25.	124.	24.	37.	39.	9.	15.	16.	19.	27.	28.	26.
18	L.A.-LONG BEACH	74.	364.	69.	107.	110.	27.	43.	43.	52.	71.	73.	61.
19	SAN FRANCISCO BAY	70.	346.	66.	101.	105.	25.	40.	41.	49.	67.	68.	57.
20	HAWAII	17.	83.	16.	24.	25.	6.	10.	10.	12.	16.	16.	13.
21	PORTLAND	40.	196.	37.	57.	59.	14.	23.	23.	27.	37.	38.	31.
22	PUDGET SOUND	39.	194.	37.	56.	58.	14.	22.	23.	27.	36.	37.	30.
23	ALASKA	16.	79.	15.	23.	24.	6.	9.	9.	11.	15.	15.	12.
	SUM (USA PORTS),S(K)	2549.	9730.	2488.	3568.	3532.	867.	1316.	1279.	1457.	1894.	1859.	1401.
	SUM (ALL PORTS),S'(K)	2776.	14409.	2644.	3930.	3903.	890.	1369.	1331.	1521.	2012.	1966.	1449.

	FROM J	TO K 13	14	15	16	17	18	19	20	21	22	23
1	NEW ENGLAND COAST	29.	356.	33.	173.	25.	59.	55.	13.	29.	29.	8.
2	NEW YORK	132.	1607.	150.	780.	111.	262.	247.	56.	129.	127.	36.
3	PHILADELPHIA	25.	306.	28.	148.	21.	49.	46.	11.	24.	24.	7.
4	BALTIMORE	42.	502.	47.	241.	34.	79.	74.	17.	39.	38.	11.
5	HAMPTON ROADS	45.	545.	50.	261.	37.	85.	79.	18.	41.	41.	12.
6	WILMINGTON, N.C.	13.	156.	14.	74.	10.	24.	22.	5.	12.	11.	3.
7	CHARLESTON	20.	242.	22.	115.	16.	36.	34.	8.	17.	17.	5.
8	SAVANNAH	22.	261.	24.	122.	17.	38.	35.	8.	18.	18.	5.
9	JACKSONVILLE	25.	300.	27.	140.	20.	43.	40.	9.	20.	20.	6.
10	MIAMI	39.	454.	41.	209.	29.	63.	58.	13.	30.	29.	8.
11	SAN JUAN	39.	456.	41.	208.	29.	61.	56.	13.	29.	28.	8.
12	TAMPA	41.	459.	40.	195.	26.	50.	46.	10.	23.	22.	6.
13	MOBILE	45.	490.	42.	203.	27.	50.	46.	10.	23.	22.	6.
14	NEW ORLEANS	523.	7792.	652.	3107.	411.	727.	662.	147.	327.	316.	88.
15	SABINE-NECHES	34.	503.	57.	267.	35.	59.	53.	12.	26.	25.	7.
16	HOUSTON-GALVESTON	190.	2735.	305.	1939.	247.	393.	354.	78.	172.	165.	46.
17	CORPUS-CHRISTI	28.	398.	44.	272.	47.	70.	62.	14.	30.	29.	8.
18	L.A.-LONG BEACH	64.	875.	91.	537.	86.	510.	424.	88.	184.	168.	45.
19	SAN FRANCISCO BAY	59.	806.	84.	490.	78.	430.	487.	98.	203.	184.	49.
20	HAWAII	14.	189.	20.	114.	18.	93.	104.	29.	58.	51.	13.
21	PORTLAND	32.	433.	45.	259.	41.	202.	220.	59.	164.	143.	37.
22	PUDGET SOUND	31.	417.	43.	248.	39.	185.	200.	53.	143.	170.	43.
23	ALASKA	12.	166.	17.	98.	15.	70.	75.	20.	52.	61.	21.
	SUM (USA PORTS),S(K)	1459.	12656.	1860.	8261.	1372.	3128.	2992.	760.	1629.	1568.	457.
	SUM (ALL PORTS),S'(K)	1504.	20448.	1917.	10200.	1419.	3638.	3479.	789.	1793.	1738.	478.

Figure E-5, Contd.

PREDICTED INTERPORT TRIPS
PER YEAR (ONE WAY)
1979

FROM J	TO K: 1	2	3	4	5	6	7	8	9	10	11	12
1 NEW ENGLAND COAST	501.	1199.	147.	164.	131.	25.	34.	29.	29.	34.	31.	19.
2 NEW YORK	836.	8005.	737.	730.	547.	101.	131.	109.	109.	128.	112.	69.
3 PHILADELPHIA	139.	999.	368.	273.	182.	32.	39.	32.	31.	36.	31.	19.
4 BALTIMORE	164.	1047.	289.	860.	429.	66.	77.	60.	57.	65.	55.	33.
5 HAMPTON ROADS	134.	802.	197.	439.	876.	102.	105.	77.	70.	77.	64.	38.
6 WILMINGTON, N.C.	38.	220.	51.	100.	150.	70.	54.	35.	30.	32.	26.	15.
7 CHARLESTON	47.	261.	58.	107.	142.	50.	153.	75.	57.	56.	44.	25.
8 SAVANNAH	41.	226.	48.	86.	108.	33.	78.	151.	86.	76.	55.	30.
9 JACKSONVILLE	39.	208.	44.	76.	91.	26.	54.	80.	181.	120.	78.	40.
10 MIAMI	40.	211.	44.	74.	87.	24.	47.	61.	104.	273.	133.	60.
11 SAN JUAN	33.	174.	36.	59.	68.	18.	34.	42.	63.	125.	244.	83.
12 TAMPA	22.	117.	24.	39.	44.	12.	21.	25.	35.	61.	90.	122.
13 MOBILE	20.	105.	21.	34.	38.	10.	18.	20.	27.	45.	59.	60.
14 NEW ORLEANS	200.	1033.	206.	334.	367.	94.	165.	183.	244.	386.	471.	426.
15 SABINE-NECHES	17.	89.	18.	29.	31.	8.	14.	15.	19.	30.	35.	30.
16 HOUSTON-GALVESTON	73.	375.	74.	119.	128.	32.	55.	60.	77.	115.	132.	107.
17 CORPUS-CHRISTI	15.	75.	15.	24.	25.	6.	11.	12.	15.	22.	24.	19.
18 L.A.-LONG BEACH	41.	206.	40.	62.	65.	16.	26.	27.	33.	47.	49.	36.
19 SAN FRANCISCO BAY	38.	189.	36.	57.	59.	15.	24.	24.	30.	42.	44.	32.
20 HAWAII	12.	62.	12.	18.	19.	5.	8.	8.	9.	13.	14.	10.
21 PORTLAND	28.	138.	26.	41.	43.	10.	17.	17.	21.	29.	30.	22.
22 PUDGET SOUND	25.	126.	24.	37.	39.	9.	15.	16.	19.	26.	27.	20.
23 ALASKA	10.	51.	10.	15.	16.	4.	6.	6.	8.	10.	11.	8.
SUM (USA PORTS),S(K)	2012.	7913.	2157.	2916.	2809.	698.	1033.	1013.	1173.	1575.	1615.	1201.
SUM (ALL PORTS),S'(K)	2513.	15918.	2525.	3776.	3685.	768.	1186.	1164.	1354.	1848.	1859.	1323.

FROM J	TO K: 13	14	15	16	17	18	19	20	21	22	23	GRAND TOTALS
1 NEW ENGLAND COAST	17.	206.	19.	96.	13.	29.	27.	6.	14.	14.	4.	
2 NEW YORK	63.	740.	67.	341.	48.	102.	95.	21.	49.	48.	13.	
3 PHILADELPHIA	17.	200.	18.	91.	13.	27.	25.	6.	13.	12.	3.	
4 BALTIMORE	30.	343.	31.	154.	21.	44.	41.	9.	21.	20.	6.	
5 HAMPTON ROADS	34.	385.	34.	171.	23.	47.	44.	10.	22.	22.	6.	
6 WILMINGTON, N.C.	13.	147.	13.	64.	9.	17.	16.	4.	8.	8.	2.	
7 CHARLESTON	21.	235.	20.	100.	14.	26.	24.	5.	12.	11.	3.	
8 SAVANNAH	25.	271.	23.	112.	15.	28.	25.	6.	13.	12.	3.	
9 JACKSONVILLE	31.	334.	28.	133.	18.	31.	28.	6.	14.	14.	4.	
10 MIAMI	45.	457.	37.	174.	23.	38.	34.	8.	17.	16.	5.	
11 SAN JUAN	55.	522.	41.	185.	24.	37.	34.	7.	16.	16.	4.	
12 TAMPA	60.	514.	38.	164.	20.	30.	27.	6.	13.	12.	3.	
13 MOBILE	118.	755.	49.	201.	24.	32.	29.	6.	14.	13.	4.	
14 NEW ORLEANS	632.	16138.	787.	2860.	319.	377.	332.	72.	157.	148.	41.	
15 SABINE-NECHES	39.	752.	147.	400.	40.	39.	34.	7.	16.	15.	4.	
16 HOUSTON-GALVESTON	132.	2252.	330.	3593.	267.	197.	170.	36.	77.	72.	20.	
17 CORPUS-CHRISTI	23.	362.	47.	385.	114.	48.	41.	9.	18.	17.	5.	
18 L.A.-LONG BEACH	39.	546.	59.	363.	62.	1274.	618.	97.	172.	140.	34.	
19 SAN FRANCISCO BAY	34.	475.	[illegible].	309.	52.	610.	1184.	140.	220.	168.	39.	
20 HAWAII	11.	148.	16.	95.	16.	138.	202.	95.	112.	76.	17.	
21 PORTLAND	23.	319.	34.	200.	33.	242.	313.	111.	522.	266.	52.	
22 PUDGET SOUND	21.	292.	30.	175.	28.	184.	224.	70.	249.	507.	74.	
23 ALASKA	8.	111.	12.	68.	11.	65.	75.	22.	70.	107.	63.	
SUM (USA PORTS),S(K)	1373.	10356.	1784.	6841.	1093.	2388.	2458.	664.	1317.	1227.	346.	56862
SUM (ALL PORTS),S'(K)	1491.	26494.	1931.	10434.	1207.	3652.	3642.	759.	1839.	1734.	409.	91521

Figure E-5, Concd.

PREDICTED INTERPORT TRIPS
PER YEAR (ONE WAY)
1980

FROM J		TO K 1	2	3	4	5	6	7	8	9	10	11	12
1	NEW ENGLAND COAST	235.	965.	156.	206.	185.	39.	55.	50.	53.	65.	59.	32.
2	NEW YORK	859.	4797.	757.	985.	874.	182.	257.	229.	241.	295.	269.	144.
3	PHILADELPHIA	134.	735.	158.	201.	176.	36.	50.	45.	47.	57.	52.	27.
4	BALTIMORE	191.	1029.	217.	376.	321.	65.	90.	79.	82.	99.	89.	46.
5	HAMPTON ROADS	179.	950.	197.	334.	389.	77.	105.	91.	93.	112.	100.	51.
6	WILMINGTON, N.C.	47.	248.	51.	85.	97.	26.	35.	30.	30.	36.	32.	16.
7	CHARLESTON	61.	319.	65.	107.	120.	32.	57.	48.	48.	56.	49.	24.
8	SAVANNAH	58.	299.	60.	98.	109.	28.	50.	57.	56.	64.	56.	26.
9	JACKSONVILLE	56.	287.	57.	93.	102.	26.	46.	51.	68.	77.	65.	30.
10	MIAMI	75.	387.	77.	124.	135.	34.	59.	65.	84.	130.	109.	47.
11	SAN JUAN	64.	326.	64.	103.	111.	28.	48.	52.	67.	100.	114.	47.
12	TAMPA	35.	179.	35.	55.	58.	14.	24.	25.	31.	44.	48.	54.
13	MOBILE	31.	158.	31.	48.	51.	13.	21.	22.	27.	38.	40.	43.
14	NEW ORLEANS	433.	2173.	420.	657.	693.	170.	280.	291.	355.	505.	534.	543.
15	SABINE-NECHES	27.	133.	26.	40.	42.	10.	17.	18.	21.	30.	32.	31.
16	HOUSTON-GALVESTON	170.	847.	163.	254.	266.	65.	106.	110.	133.	187.	195.	185.
17	CORPUS-CHRISTI	27.	135.	26.	40.	42.	10.	17.	17.	21.	29.	30.	28.
18	L.A.-LONG BEACH	80.	398.	76.	117.	121.	29.	47.	48.	57.	78.	80.	67.
19	SAN FRANCISCO BAY	76.	376.	72.	110.	114.	27.	44.	45.	53.	73.	74.	62.
20	HAWAII	18.	91.	17.	27.	27.	7.	11.	11.	13.	17.	18.	15.
21	PORTLAND	43.	213.	40.	62.	64.	15.	25.	25.	29.	40.	41.	33.
22	PUDGET SOUND	42.	204.	39.	59.	61.	15.	24.	24.	28.	38.	39.	32.
23	ALASKA	19.	95.	18.	28.	29.	7.	11.	11.	13.	18.	18.	14.
	SUM (USA PORTS),S(K)	2725.	10547.	2664.	3833.	3798.	929.	1422.	1387.	1582.	2058.	2029.	1543.
	SUM (ALL PORTS),S'(K)	2960.	15344.	2822.	4209.	4187.	955.	1479.	1444.	1650.	2188.	2143.	1597.

FROM J		TO K 13	14	15	16	17	18	19	20	21	22	23
1	NEW ENGLAND COAST	30.	369.	34.	180.	26.	61.	57.	13.	30.	30.	8.
2	NEW YORK	135.	1647.	153.	800.	114.	269.	253.	58.	132.	131.	37.
3	PHILADELPHIA	25.	309.	29.	149.	21.	50.	47.	11.	24.	24.	7.
4	BALTIMORE	43.	521.	48.	251.	36.	82.	77.	18.	40.	40.	11.
5	HAMPTON ROADS	47.	571.	53.	273.	39.	89.	83.	19.	43.	43.	12.
6	WILMINGTON, N.C.	15.	175.	16.	83.	12.	27.	25.	6.	13.	13.	4.
7	CHARLESTON	22.	263.	24.	124.	18.	39.	37.	8.	19.	19.	5.
8	SAVANNAH	24.	288.	26.	135.	19.	42.	39.	9.	20.	20.	6.
9	JACKSONVILLE	27.	320.	29.	149.	21.	46.	42.	10.	22.	21.	6.
10	MIAMI	43.	501.	45.	231.	32.	69.	64.	15.	33.	32.	9.
11	SAN JUAN	42.	490.	44.	223.	31.	65.	60.	14.	31.	30.	9.
12	TAMPA	46.	510.	44.	217.	29.	56.	51.	11.	26.	25.	7.
13	MOBILE	50.	543.	46.	225.	30.	55.	51.	11.	25.	24.	7.
14	NEW ORLEANS	614.	9141.	765.	3646.	482.	853.	776.	173.	384.	371.	103.
15	SABINE-NECHES	35.	504.	57.	268.	35.	59.	53.	12.	26.	25.	7.
16	HOUSTON-GALVESTON	204.	2926.	326.	2074.	264.	420.	379.	83.	184.	177.	49.
17	CORPUS-CHRISTI	30.	431.	47.	295.	51.	75.	68.	15.	33.	31.	9.
18	L.A.-LONG BEACH	70.	956.	100.	587.	94.	558.	464.	96.	201.	184.	49.
19	SAN FRANCISCO BAY	65.	876.	91.	532.	85.	467.	529.	107.	221.	200.	53.
20	HAWAII	15.	205.	21.	124.	20.	102.	113.	31.	63.	56.	15.
21	PORTLAND	35.	469.	48.	281.	44.	219.	239.	64.	177.	155.	40.
22	PUDGET SOUND	33.	440.	45.	261.	41.	195.	210.	56.	151.	179.	45.
23	ALASKA	15.	201.	21.	119.	19.	85.	91.	24.	63.	74.	25.
	SUM (USA PORTS),S(K)	1615.	13515.	2055.	9153.	1512.	3425.	3279.	833.	1784.	1725.	498.
	SUM (ALL PORTS),S'(K)	1665.	22[illegible]	2112.	11227.	1563.	3983.	3808.	864.	1961.	1904.	523.

Figure E-5, Contd.

PREDICTED INTERPORT TRIPS
PER YEAR (ONE WAY)
1981

	FROM J \ TO K	1	2	3	4	5	6	7	8	9	10	11	12
1	NEW ENGLAND COAST	240.	983.	158.	209.	188.	40.	56.	51.	54.	66.	60.	33.
2	NEW YORK	870.	4855.	767.	997.	885.	185.	260.	232.	244.	299.	273.	146.
3	PHILADELPHIA	135.	739.	159.	202.	177.	36.	51.	45.	47.	57.	52.	27.
4	BALTIMORE	195.	1048.	221.	382.	327.	66.	91.	80.	83.	100.	91.	47.
5	HAMPTON ROADS	183.	972.	201.	342.	398.	79.	107.	93.	95.	114.	102.	52.
6	WILMINGTON, N.C.	50.	261.	53.	89.	102.	28.	37.	31.	32.	38.	33.	17.
7	CHARLESTON	63.	331.	67.	111.	124.	33.	60.	50.	50.	58.	51.	25.
8	SAVANNAH	60.	313.	63.	103.	114.	30.	53.	60.	58.	67.	59.	27.
9	JACKSONVILLE	57.	296.	59.	96.	105.	27.	47.	53.	70.	79.	68.	31.
10	MIAMI	79.	405.	80.	129.	141.	36.	62.	68.	88.	136.	114.	49.
11	SAN JUAN	66.	337.	67.	106.	115.	29.	50.	54.	69.	104.	118.	48.
12	TAMPA	37.	188.	37.	57.	61.	15.	25.	26.	32.	47.	50.	57.
13	MOBILE	33.	166.	32.	50.	53.	13.	22.	23.	28.	40.	42.	45.
14	NEW ORLEANS	465.	2333.	451.	706.	744.	183.	301.	312.	381.	542.	573.	583.
15	SABINE-NECHES	27.	133.	26.	40.	42.	10.	17.	18.	21.	30.	32.	31.
16	HOUSTON-GALVESTON	175.	874.	168.	262.	275.	67.	110.	113.	137.	193.	202.	191.
17	CORPUS-CHRISTI	28.	140.	27.	42.	44.	11.	17.	18.	21.	30.	31.	29.
18	L.A.-LONG BEACH	84.	415.	79.	122.	126.	30.	49.	50.	59.	81.	83.	70.
19	SAN FRANCISCO BAY	79.	391.	74.	114.	118.	28.	46.	46.	55.	76.	77.	64.
20	HAWAII	19.	95.	18.	28.	29.	7.	11.	11.	13.	18.	18.	15.
21	PORTLAND	45.	221.	42.	64.	66.	16.	26.	26.	31.	42.	43.	35.
22	PUDGET SOUND	43.	210.	40.	61.	63.	15.	24.	24.	29.	39.	40.	32.
23	ALASKA	21.	104.	20.	30.	31.	7.	12.	12.	14.	19.	20.	16.
	SUM (USA PORTS),S(K)	2814.	10955.	2750.	3960.	3930.	963.	1474.	1436.	1641.	2139.	2114.	1613.
	SUM (ALL PORTS),S'(K)	3054.	15810.	2909.	4342.	4328.	991.	1534.	1496.	1711.	2275.	2232.	1670.

	FROM J \ TO K	13	14	15	16	17	18	19	20	21	22	23
1	NEW ENGLAND COAST	31.	376.	35.	183.	26.	62.	59.	13.	31.	30.	9.
2	NEW YORK	137.	1667.	155.	809.	115.	272.	256.	59.	134.	132.	38.
3	PHILADELPHIA	26.	311.	29.	150.	21.	50.	47.	11.	24.	24.	7.
4	BALTIMORE	44.	530.	49.	255.	36.	84.	79.	18.	41.	40.	12.
5	HAMPTON ROADS	48.	584.	54.	279.	40.	91.	85.	19.	44.	44.	12.
6	WILMINGTON, N.C.	15.	185.	17.	88.	12.	28.	26.	6.	14.	13.	4.
7	CHARLESTON	23.	274.	25.	129.	18.	41.	38.	9.	20.	19.	5.
8	SAVANNAH	25.	301.	28.	141.	20.	44.	41.	9.	21.	21.	6.
9	JACKSONVILLE	28.	330.	30.	154.	22.	47.	44.	10.	22.	22.	6.
10	MIAMI	44.	524.	48.	242.	34.	72.	67.	15.	34.	34.	10.
11	SAN JUAN	43.	506.	46.	231.	32.	68.	63.	14.	32.	31.	9.
12	TAMPA	48.	536.	46.	228.	31.	59.	54.	12.	27.	26.	7.
13	MOBILE	52.	569.	49.	235.	32.	58.	53.	12.	26.	26.	7.
14	NEW ORLEANS	859.	9816.	821.	3915.	517.	916.	834.	183.	413.	398.	111.
15	SABINE-NECHES	35.	504.	57.	268.	35.	59.	53.	12.	26.	25.	7.
16	HOUSTON-GALVESTON	210.	3021.	337.	2142.	273.	434.	391.	86.	190.	183.	51.
17	CORPUS-CHRISTI	32.	448.	49.	306.	53.	78.	70.	15.	34.	32.	9.
18	L.A.-LONG BEACH	73.	997.	104.	611.	98.	581.	484.	100.	209.	192.	51.
19	SAN FRANCISCO BAY	67.	911.	95.	554.	89.	486.	550.	111.	230.	208.	55.
20	HAWAII	16.	214.	22.	129.	21.	106.	118.	32.	66.	58.	15.
21	PORTLAND	36.	487.	50.	291.	46.	227.	248.	67.	184.	161.	41.
22	PUDGET SOUND	34.	451.	46.	268.	42.	200.	216.	57.	154.	183.	46.
23	ALASKA	16.	218.	22.	129.	20.	92.	99.	26.	69.	80.	27.
	SUM (USA PORTS),S(K)	1690.	13944.	2157.	9595.	1580.	3574.	3425.	866.	1861.	1799.	518.
	SUM (ALL PORTS),S'(K)	1742	23760	2214.	11737.	1633.	4155.	3975.	898.	2045.	1982.	545.

Figure E-5, Contd.

PREDICTED INTERPORT TRIPS
PER YEAR (ONE WAY)
1982

	FROM J \ TO K	1	2	3	4	5	6	7	8	9	10	11	12
1	NEW ENGLAND COAST	244.	1001.	161.	213.	191.	40.	57.	52.	54.	67.	61.	33.
2	NEW YORK	860.	4914.	776.	1009.	895.	187.	263.	235.	247.	303.	276.	148.
3	PHILADELPHIA	136.	742.	160.	203.	178.	37.	51.	45.	47.	57.	52.	27.
4	BALTIMORE	198.	1067.	225.	389.	333.	68.	93.	82.	85.	102.	92.	48.
5	HAMPTON ROADS	187.	994.	206.	350.	407.	81.	110.	95.	97.	117.	105.	53.
6	WILMINGTON, N.C.	52.	275.	56.	94.	107.	29.	39.	33.	33.	40.	35.	17.
7	CHARLESTON	66.	344.	70.	115.	129.	34.	62.	52.	51.	60.	53.	26.
8	SAVANNAH	63.	327.	66.	107.	119.	31.	55.	62.	61.	70.	61.	29.
9	JACKSONVILLE	59.	305.	61.	99.	108.	28.	49.	54.	72.	81.	70.	31.
10	MIAMI	83.	423.	84.	135.	147.	38.	65.	71.	92.	142.	119.	51.
11	SAN JUAN	68.	348.	69.	110.	119.	30.	51.	55.	71.	107.	122.	50.
12	TAMPA	39.	197.	38.	60.	64.	16.	26.	27.	34.	49.	52.	59.
13	MOBILE	35.	173.	34.	53.	56.	14.	23.	24.	29.	42.	44.	47.
14	NEW ORLEANS	497.	2494.	482.	754.	795.	195.	321.	334.	407.	579.	613.	623.
15	SABINE-NECHES	27.	134.	26.	40.	42.	10.	17.	18.	21.	30.	32.	31.
16	HOUSTON-GALVESTON	181.	902.	174.	270.	283.	69.	113.	117.	141.	199.	208.	197.
17	CORPUS-CHRISTI	29.	145.	28.	43.	45.	11.	18.	18.	22.	31.	33.	30.
18	L.A.-LONG BEACH	87.	431.	82.	127.	131.	32.	51.	52.	61.	85.	87.	72.
19	SAN FRANCISCO BAY	82.	406.	77.	119.	123.	30.	48.	48.	57.	79.	80.	67.
20	HAWAII	20.	98.	19.	29.	30.	7.	11.	12.	14.	19.	19.	16.
21	PORTLAND	47.	229.	44.	67.	69.	17.	27.	27.	32.	44.	44.	36.
22	PUDGET SOUND	44.	215.	41.	62.	64.	15.	25.	25.	29.	40.	41.	33.
23	ALASKA	23.	112.	21.	32.	33.	8.	13.	13.	15.	21.	21.	17.
	SUM (USA PORTS),S(K)	2903.	11362.	2840.	4091.	4061.	998.	1526.	1489.	1700.	2222.	2198.	1682.
	SUM (ALL PORTS),S'(K)	3147.	16276.	3000.	4480.	4468.	1027.	1588.	1551.	1772.	2364.	2320.	1741.

	FROM J \ TO K	13	14	15	16	17	18	19	20	21	22	23
1	NEW ENGLAND COAST	31.	383.	36.	187.	27.	63.	60.	14.	31.	31.	9.
2	NEW YORK	139.	1687.	157.	819.	117.	276.	259.	59.	135.	134.	38.
3	PHILADELPHIA	26.	312.	29.	151.	21.	50.	47.	11.	25.	24.	7.
4	BALTIMORE	45.	540.	50.	260.	37.	85.	80.	18.	42.	41.	12.
5	HAMPTON ROADS	50.	597.	55.	286.	40.	93.	87.	20.	45.	45.	13.
6	WILMINGTON, N.C.	16.	194.	18.	92.	13.	30.	28.	6.	14.	14.	4.
7	CHARLESTON	24.	284.	26.	134.	19.	42.	40.	9.	20.	20.	6.
8	SAVANNAH	26.	314.	29.	147.	21.	46.	43.	10.	22.	22.	6.
9	JACKSONVILLE	29.	340.	31.	158.	22.	48.	45.	10.	23.	23.	6.
10	MIAMI	46.	548.	50.	252.	35.	76.	70.	16.	36.	35.	10.
11	SAN JUAN	45.	523.	47.	238.	33.	70.	65.	15.	33.	32.	9.
12	TAMPA	50.	561.	49.	239.	32.	62.	57.	13.	28.	27.	8.
13	MOBILE	54.	596.	51.	246.	33.	61.	56.	12.	28.	27.	7.
14	NEW ORLEANS	704.	10491.	678.	4184.	553.	979.	891.	198.	441.	425.	119.
15	SABINE-NECHES	35.	505.	57.	266.	35.	59.	53.	12.	26.	25.	7.
16	HOUSTON-GALVESTON	217.	3117.	348.	2210.	282.	447.	403.	89.	196.	188.	52.
17	CORPUS-CHRISTI	33.	465.	51.	318.	55.	81.	73.	16.	35.	34.	9.
18	L.A.-LONG BEACH	76.	1037.	108.	636.	102.	605.	503.	104.	218.	200.	53.
19	SAN FRANCISCO BAY	70.	946.	98.	575.	92.	504.	571.	116.	239.	216.	57.
20	HAWAII	16.	222.	23.	134.	21.	110.	122.	34.	68.	61.	16.
21	PORTLAND	37.	505.	52.	302.	48.	236.	257.	69.	191.	167.	43.
22	PUDGET SOUND	34.	462.	48.	275.	43.	205.	221.	59.	158.	188.	47.
23	ALASKA	18.	235.	24.	139.	22.	100.	106.	28.	74.	86.	30.
	SUM (USA PORTS),S(K)	1767.	14373.	2258.	10040.	1648.	3723.	3566.	904.	1937.	1877.	538.
	[illegible]	1941.	26866.	2315.	12250.	1703.	4328.	4137.	938.	2128.	2065.	568.

APPENDIX F

EXAMPLE OF COMPUTER-GENERATED REPORT ON VESSEL LOCATION AND STATUS

APPENDIX F

EXAMPLE OF COMPUTER-GENERATED REPORT ON VESSEL LOCATION AND STATUS

REPORT NO. SR630-01
DATE-TIME-RUN 06/17/76-09:25

PUGET SOUND VESSEL NFORMATION BULLETIN

PUBLISHED BY
MARINE TERMINALS
PORT OF SEATTLE
PIER 66 SEATTLE WA 98111
206-587-4646

PUGET SOUND SHIPPING

VESSELS IN PORT

VESSEL	FLAG	TYPE	LOCATION	TO SAIL	DESTINATION	AGENT
AGELOS PROTOSTATIS	LIB	FRTR	OLYMPIA	JUN.19	JAPAN	OLYMPIC SS
ATLANTIC PIONEER	PAN	FRTR	OLYMPIA	JUN.18	JAPAN	INT'L SHPG
ATLANTIC TRADER	US	TKR	BELLINGHAM		CALIF	ARCO
CALIFORNIAN	US	FRTR	TERM 18	JUN.19	HAWAII	MATSON
CESIRA	PAN	FRTR	TERM 115	JUN.18	JAPAN	WMS DIMOND
COLUMBIA STAR	UK	CNTR	TERM 25	JUN.18	EUROPE	GENERAL SS
CORAL ARCADIA	LIB	FRTR	TAC WEYCO	JUN.20	JAPAN	CASCADE SHPG
EASTERN MILL	JAP	FRTR	PORT ANGELES	JUN.26	JAPAN	KERR SS
GARCILASO	PERU	FRTR	TAC TERM 7		SO AMER	OVERSEAS SHPG
GREAT LAND	US	FRTR	TAC TERM 7	JUN.18	ALASKA	TOTE
HOUSTON	US	TKR	ANACORTES	JUN.18	COAST	JT STEEB
ISOKAZE MARU	JAP	FRTR	TERM 91	JUN.21	BC	WMS DIMOND
JAPAN VENTURE	LIB	FRTR	EVERETT	JUN.20	JAPAN	JAPAN LINE
KOWA MARU	JAP	TKR	ANACORTES	JUN.18	INDONESIA	INT'L
MARITIME PIONEER	PAN	FRTR	PORT ANGELES	JUN.19	ASIA	CASCADE SHPG
OINOUSSIAN SUPERORITY	GRK	FRTR	PORT ANGELES	JUN.16	ASIA	CASCADE SHPG
PANGUEON	SING	FRTR	TAC BLAIR WY	JUN.18	FAR EAST	CASCADE SHPG
S O HIMACHAL PRADESH	IND	FRTR	TAC PC TERM	JUN.19	INDIA	NORTON LILLY
SUMMIT	US	FRTR	TERM 7	JUL.15	TO BE SCRAPPED	SEA-LAND

SUNNY STATE	LIB	FRTR	TERM 91	JUN.20	JAPAN	WMS DIMOND
WAYWAY	LIB	FRTR	TAC WEYCO	JUN.16	JAPAN	KERR SS

SAILINGS

VESSEL	FLAG	TYPE	LOCATION	DESTINATION	AGENT
			JUNE 16		
KYOKO MARU	LIB	FRTR	PORT ANGELES	JAPAN	FRITZ MARITIME
OCEAN MELODY	PAN	FRTR	TERM 20	JAPAN	FRITZ MARITIME
PERMINA SAMUDRA V	LIB	TKR	TAC BLAIR WY	INDONESIA	JT STEEB
			JUNE 17		
AGELOS PROTOSTATIS	LIB	FRTR	PORT ANGELES	JAPAN	OLYMPIC SS
ATLANTIC TRADER	US	TKR	CHERRY POINT	CALIF	ARCO
FERNRIVER	NOR	FRTR	FERNDALE	AUSTRALIA	OLYMPIC SS
JAPAN VENTURE	LIB	FRTR	TERM 105	JAPAN	JAPAN LINE
OCEAN BRAVE	JAP	FRTR	PORT ANGELES	JAPAN	KERR SS
OREGON	US	FRTR	TERM 20	FAR EAST	STATES LINE
ORIENTAL SOVEREIGN	LIB	FRTR	TAC WEYCO	JAPAN	WMS DIMOND
PHILADELPHIA	US	CNTR	TERM 5	ALASKA	SEA-LAND
STAR MOSTANGEN	NOR	FRTR	TERM 86	PHILIPPINES	FREIGHTERS
TEXACO GEORGIA	US	TKR	TERM 15	TEXAS	JT STEEB

AD-A054 700 ARINC RESEARCH CORP ANNAPOLIS MD F/G 15/5
THE FEASIBILITY OF A NATIONAL VESSEL-TRAFFIC INFORMATION SYSTEM--ETC(U)
MAY 78 M W MITCHELL
UNCLASSIFIED 1331-02-2-1744 NL

2 OF 2
AD
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DATE
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EXPECTED ARRIVALS

VESSEL	FLAG	TYPE	LOCATION	FROM	AGENT
			JUNE 18		
ALEKSANDR VERMISHEV	RUSS	FRTR	EVERETT	ASIA	MORFLOT
DAIEI MARU	JAP	TKR	FERNDALE	ASIA	JAPAN LINE
GOLDEN ARROW	JAP	CNTR	TERM 18	ASIA	JAPAN LINE
LUIGI D AMICO	ITAL		TERM 20	NORTH AMERICA	INT'L SHPG
MINETAMA MARU	JAP	FRTR	EVERETT	ASIA	INT'L SHPG
MOBILE	US	CNTR	TERM 5	ALASKA	SEA-LAND
NOVIKOV-PRIBOY	RUSS	FRTR	TERM 18	ASIA	MORFLOT
PRESIDENT JOHNSON	US	CNTR	TERM 25	ASIA	APL
RIO ABAUCAN	ARG	FRTR	TAC TERM 1	AUSTRALIA	TRANS TRANS
SEA-LAND MC LEAN	US	CNTR	TERM 5	ASIA	SEA-LAND
			JUNE 19		
ATLANTIC ENDEAVOR	US	TKR	CHERRY POINT	CALIFORNIA	ARCO
CASUARINA	DAN	FRTR	TERM 115	NORTH AMERICA	GEO. S. BUSH
COLUMBUS COROMANDEL	GER	CNTR	TAC TERM 4	HAWAII	BAKKE STEAMSHIP
GULAR SOLVEIG	LIB	TKR	ANACORTES	ASIA	JT STEEB
MONTROSE	LIB	FRTR	TERM 20	ASIA	CASCADE SHPG
PRESIDENT TAFT	US	CNTR	TERM 25	ASIA	APL
			JUNE 20		
ALEKSANDR VERMISHEV	RUSS	FRTR	TAC BLAIR WY	ASIA	MORFLOT
AMERICAN RACER	US	FRTR	TAC TERM 4	CALIFORNIA	ATLAS SS
ARCO SAG RIVER	US	TKR	CHERRY POINT	ALASKA	ARCO

APPENDIX G

DETAILED DESCRIPTIONS OF ALTERNATIVE SYSTEM CONFIGURATIONS

GENERAL SYSTEM TRADEOFF CONSIDERATIONS

OBJECTIVE

The purpose of this paper is to present the basic considerations and tradeoffs for the selection of the preferred teleprocessing support alternatives associated with the design and installation of a national vessel traffic information system (NAVTIS).

The two principal components of a NAVTIS are:

(1) The telecommunications network required to serve all the NAVTIS participants

(2) The information processing and retrieval system that receives data from each of the regional ship intelligence agencies and produces reports

Various telecommunications networks can be combined with any one of a variety of centralized computer system alternatives to yield a workable NAVTIS. This paper describes some combinations that appeared to be attractive for the NAVTIS application. Two configurations were selected for analysis. The first used a specialized telecommunications network linked to a central computer system(s) which was supported entirely by a single vendor. This is referred to as the Specialized Value Added Network (S-VAN). The second configuration analyzed required the computer or data processing system to be owned and operated by the NAVTIS national office, and the telecommunica-

tions network services were supplied by a "Value Added" vendor or through the facilities of existing telephone companies (direct dial-up). This latter configuration is referred to as the Centralized Data Processing Network.

A description of these systems and their components is given below.

TELECOMMUNICATIONS ALTERNATIVES

In its simplest form, a Value Added Network (VAN) is a highly interconnected telecommunication network consisting of numerous minicomputer switches (nodes) whose main purpose is to dynamically route on a national or international level each user's data requirements.

The following is offered to clarify the distinction between a "common carrier" and a VAN. Very simply, a "common carrier" (resource) such as American Telephone and Telegraph owns and provides, on a monthly lease or dial-up basis, only the basic communication channels linking any two or more distinct users in support of their individual requirements. There is little additional value added beyond this basic service offered.

A VAN, however, is a user of the aforementioned resource. It leases circuits from a wide variety of resources such as the telephone companies, specialized common carriers (two of which are Microwave Communication Incorporated (MCI) and Southern Pacific Communications (SPC)), and the domestic satellite carriers, such as American Satellite Corporation (ASC) and RCA Globcom. The VAN is an integration of all such circuits via Nodal processors and provides essentially one unique global VAN.

Accordingly, the Value Added to this network is derived by sharing wideband channel facilities (transmission paths) amongst many users whose circuit requirements may vary significantly. Economies of scale are inherent in this type of network and line charges are incurred only for time and bandwidth used without regard for the distance data is transported. Thus, circuit charges are based primarily on the quantity of data transmitted rather than on holding time or dedicated bandwidth.

NETWORK ORGANIZATION

Inasmuch as the mode of data transfer through a VAN is usually presented in "packet" form, it would be useful at this point to examine the "packet switching" concept.

Message or data flow through the VAN commences when a customer enters data from a terminal. This information is routed to the nearest VAN switching node via leased-line or dial-up circuit. At the switching node, these data transfers are blocked into pre-established block lengths (packets) of up to 128 characters and retransmitted through the VAN to its destination over any available network path. Since each packet has the address location included in its header-frame, individual packets may take alternate routes in arriving at a final destination; upon arrival, packets are reassembled into the message transmitted.

Following the transmission over a communication line, packets of data are checked for errors and retransmitted if necessary until correctly received. Reliability in this type of network is high since the use of powerful error checking codes result in an undetected error occurring no more than once in about 10^{11} bits.

INFORMATION PROCESSING AND RETRIEVAL ALTERNATIVES

Thus far, attention has been limited to routing information through a VAN, however, it is also necessary to create data base files fully supported by available computer processing services. This is essential if the system is to be responsive to real time information and summary data as needed.

Three alternatives are available to support this requirement and largely depend on the selection of the Value Added Carrier.

- TELENET - Choosing Telenet as a reference VAN mandates the need to pursue additional vendor support. Requirements for the network requires the following amalgamation of system components not supported by Telenet:
  - A central processing unit with its associated software and hardware
  - A front-end communication controller with its associated hardware and software
  - Remote site devices (CRT and printer)

  A typical network is shown in Figure G1.

- TIMESHARE Services (S-VAN) - If a computer time-sharing service is chosen as the reference system, their support capabilities extend beyond the somewhat limited teleprocessing services provided by Telenet. Actually, TIMESHARE companies can provide not only the Host computer but also any required CPU software support, hardware interfacing, and remote data terminals as well. There are local telephone connections to the host computer available in most of the major cities within the U. S., in addition to local connections in

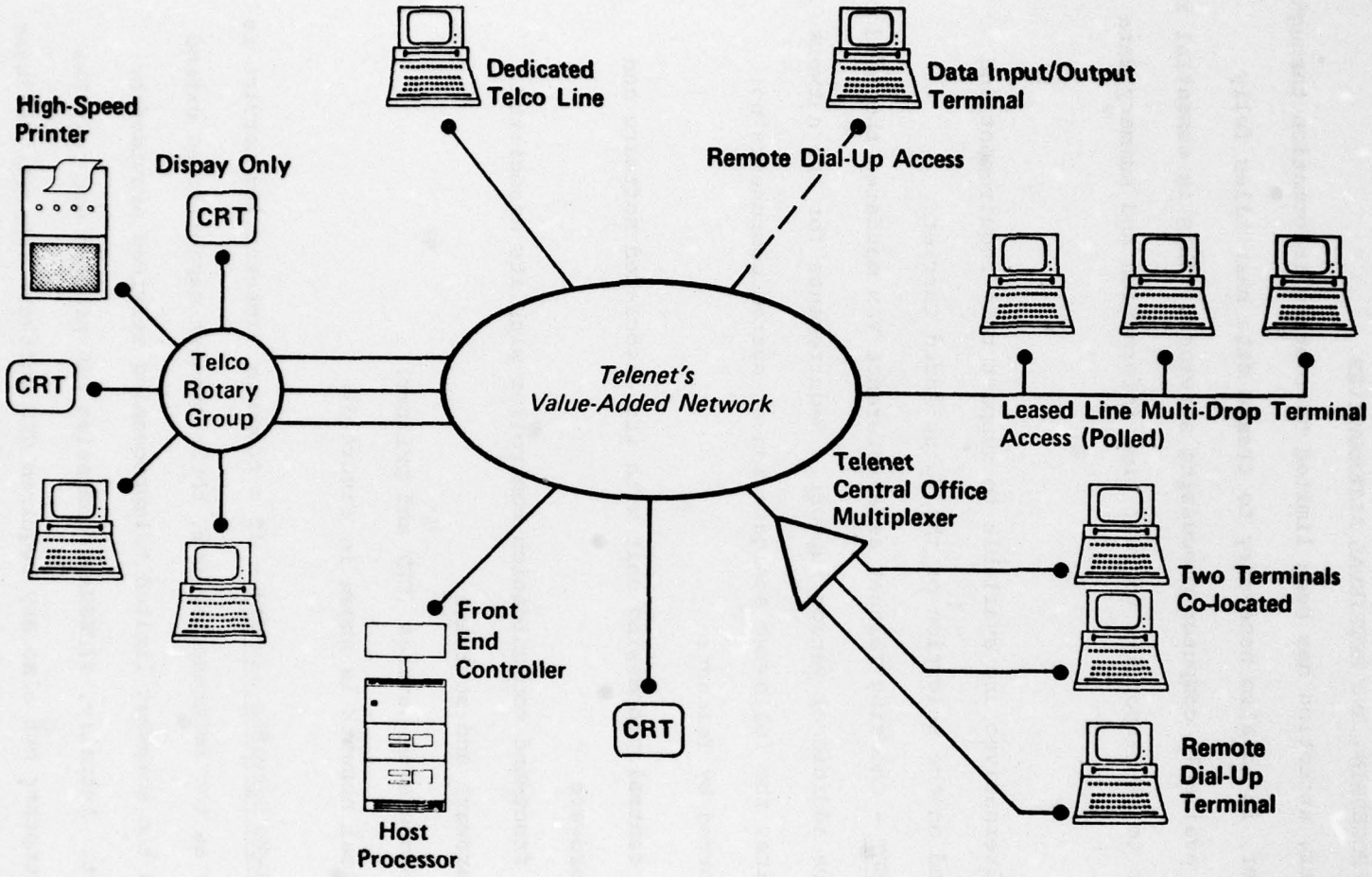

Figure G-1. **TERMINAL ACCESS TO TELENET**

many of the major cities in Europe. Advantages to this type of total system responsibility appear very attractive. First, capital expenditure and risk for a feasibility study and full implementation in a pilot program of the envisaged network are minimal. Second, total system responsibility resides with only one vendor -- a benefit most obvious when pressing needs for services are high but one or more system elements are marginally operational. Multi-system vendors at this point tend to be reticent in accepting any responsibility to localize and repair unidentifiable network malfunctions. Inasmuch as there resides little telecommunications expertise, at least initially, within the envisaged national organization, users of the network would be hard pressed to provide the necessary technical assistance to coordinate repairs and in this respect both the usefulness and success of the envisaged network is, at best, questionable. Third, the long term user's commitment for this total system offering is usually limited to between one to three months. Thus, after the first month or two of system operation if the user decides his requirements have changed such that he no longer needs this kind of system support he simply cancels his service contract without incurring monetary penalties.

CENTRALIZED DATA PROCESSING NETWORK

Centralized data processing can be supported in various circuit configurations -- two alternatives will be considered:

1. Centralized Host computer accessed via a VAN
2. Centralized Host computer accessed by remote dial-up service

Alternative 1

This alternative has been previously considered under the Value Added Network discussion so we will begin by considering Alternative 2

Alternative 2

This alternative considers, as the reference system, one central host to directly serve every user terminal within the network. Access to the network is available by direct dial-up over a series of WATS lines terminating in a rotary group at the central computer site.

Network Configuration

In this configuration, each terminal would be provided with a telephone handset from which data may be entered into or extracted from the resident common data base. Network management would be minimized since there would be no requirements for multiplexers and concentrators (see Figure G2).

Circuit Utilization

This alternative precludes the availability of dedicated lines (circuits); therefore, the availability for either dial-in or dial-out must be on a contention basis. Thus careful attention must be given in the initial design phase to define very well the expected average number of queries per day (or busy hour(s)) together with the average data transferred during each transmission.

Specifically, this information provides the basis for a cost/benefit analysis to answer the very crucial question of how many trunks should be leased to provide access to and from the computer.

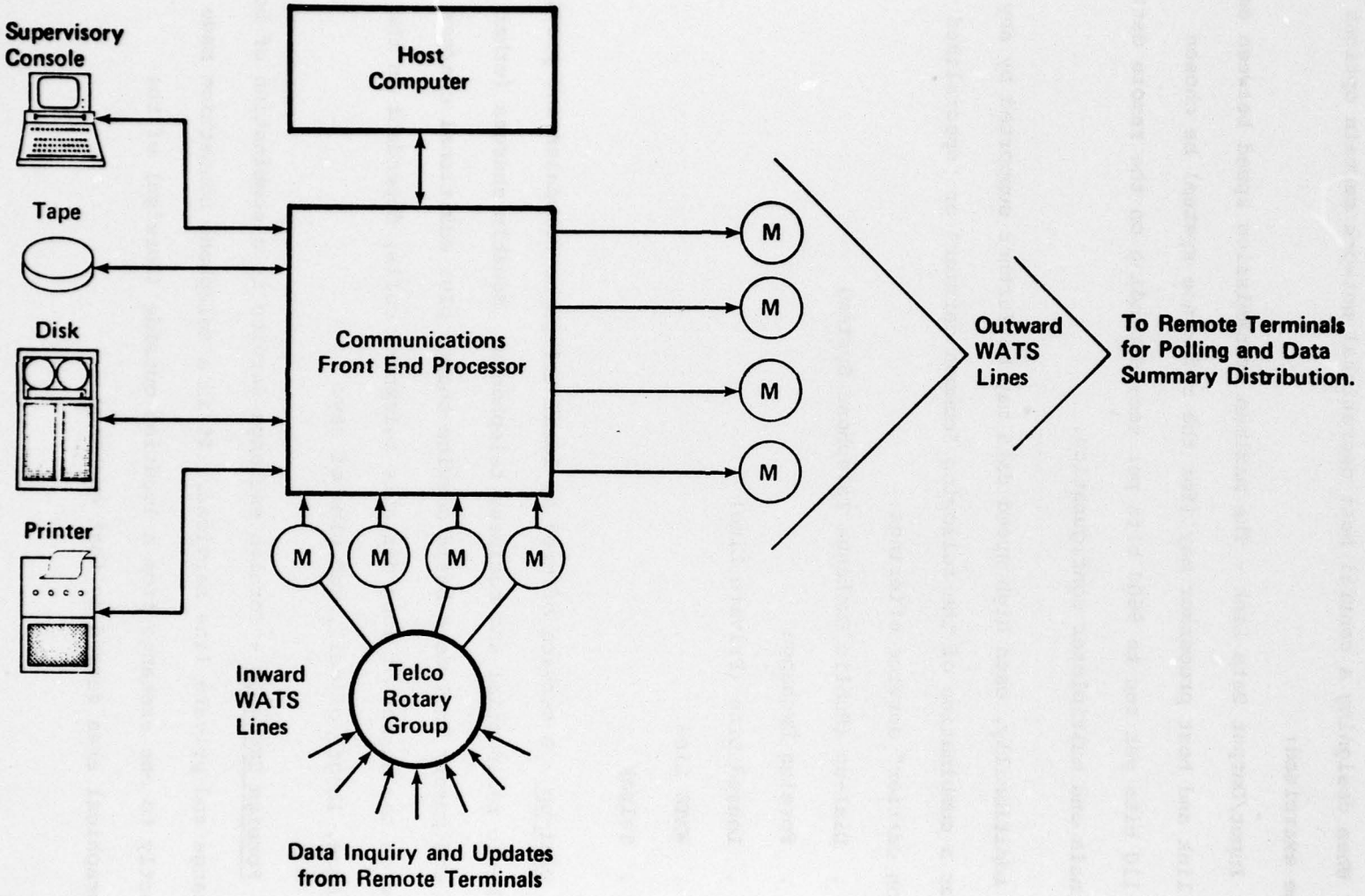

Figure G-2. CENTRALIZED TELECOMMUNICATIONS NETWORK

Network Design Considerations

When designing a central host operational network certain options may be exercised:

Input/Output Data Link - The maximum transmission speed between each data link and host processor may (for the reference system) be chosen from 110 bits per sec to 9600 bits per sec; depending on the remote data terminals and multiplexer configuration.

Additionally, each high speed data may be further supported by any one or a combination of the following "common carrier" or "specialized common carrier" service offerings:

- Dial-up (Public Exchange Telephone System)
- Foreign Exchange
- Leased Line (Private Line)
- WATS Line
- Telpak

Dial-up - A service offered by local telephone companies and provides the basic residential and business telephones. Monthly charges (other than equipment) include a basic service charge plus additional charges based on the number of long distance telephone calls; dependent on the distance, length of call, and time of day.

Foreign Exchange - Foreign exchange service is a combination of both exchange and private line services. It is a telephone connection made directly to one exchange from a location outside (foreign) of the geographical area served by that exchange.

Leased Line - This service provides for a dedicated private line (non-switched) providing unlimited use for a fixed monthly charge.

WATS Line - A Wide Area Telephone Service is a special arrangement of both the access to the telephone system and charges for using it. Access to the telephone network is geographically divided (for the entire continental U.S.) into bands or zones.

To make this service available to users at a single location, outward WATS (one-way originating service) should be used. On the other hand, to allow users to call from a distant location (one-way originating) inward WATS would be used.

Presently, the cost for this service (outward or inward WATS) is arranged as follows:

- Full Business Day (FB) - unlimited calling for up to 240 hours per month to the service area selected.
- Measured Time (MT) - provides up to 10 hours of unlimited calling per month to the service area selected, for one monthly fee.
- Additional Period - these charges are billed for excess time over the basic FB and MT.

Telpak - A Telpak service is a group-channel offering in which common carriers provide arrangements at a discount for groups of private line channels (circuits) that terminate in the same two locations. The basic building block of Telpak groups is 12 equivalent voice channels.

The purpose of presenting the foregoing service offerings is simply to indicate the scope of considerations future telecommunications management must task itself with to continually provide the most efficient and cost-effective data communications system.

SUMMARY/CONCLUSIONS

The following summary table (See Table G1) is included to highlight the advantages and disadvantages associated with the two alternative reference systems presented in this working paper.

It follows from Table G1 that in order to meet such requirements at minimal risk, little capital resources and a limited telecommunications staff, the probability of a successful pilot program designed to demonstrate the need and versatility of a global network does in fact present very strong arguments for pursuing the S-VAN alternative system supported by one of the available computer timesharing service companies.

Table G-1. COMPARATIVE FEATURES OF ALTERNATIVE SYSTEMS FOR NAVTIS

SYSTEM	ADVANTAGES	DISADVANTAGES
Specialized Value Added Network (S-VAN) (Service Offering By Computer Time-Share Company)	. Full System Support (Vendor) . Little Capital Investment . Short Term Commitment . Low Risk of System Failure . Reliability/Availability Very High . Dynamic Circuit Routing . Error Checking at Cities Served as well as Throughout the Network . Quick Response Time of Data Through System . Does not require Telecommunications Personnel to Monitor Program and System Operations	. Long Distance Call Required for Cities not Local to Input Node . No Cost Advantage Through Increased Usage
Central Data Processing Network with VAN Support (owned system) (CDPN + VAN)	. Same Advantages as above for Data Telecommunication Network . Growth at Little Additional Cost . Can Perform Other EDP Functions at Little Additional Cost .Low Telecommunications Costs	. Long Distance Call Required for Cities not Local to Input Node . Requires Relatively Large Capital Investment . Requires Communications Specialist for Support/Management . No EDP backup in case of failure
Central Data Processing Network with Direct Dial-Up System (owned system) (CDPN + DDU)	. Growth at Little Additional Cost . Can Perform Other EDP Functions at Little Additional Cost	. Relatively High Communications Line Cost . No Error Checking of Data . Requires Relatively Large Capital Investment . Requires Communications Specialist for Support/Management . No EDP backup in case of failure

APPENDIX H

PLAN FOR DEVELOPMENT AND IMPLEMENTATION OF PROTOTYPE SYSTEM DEMONSTRATION AND CONFERENCE

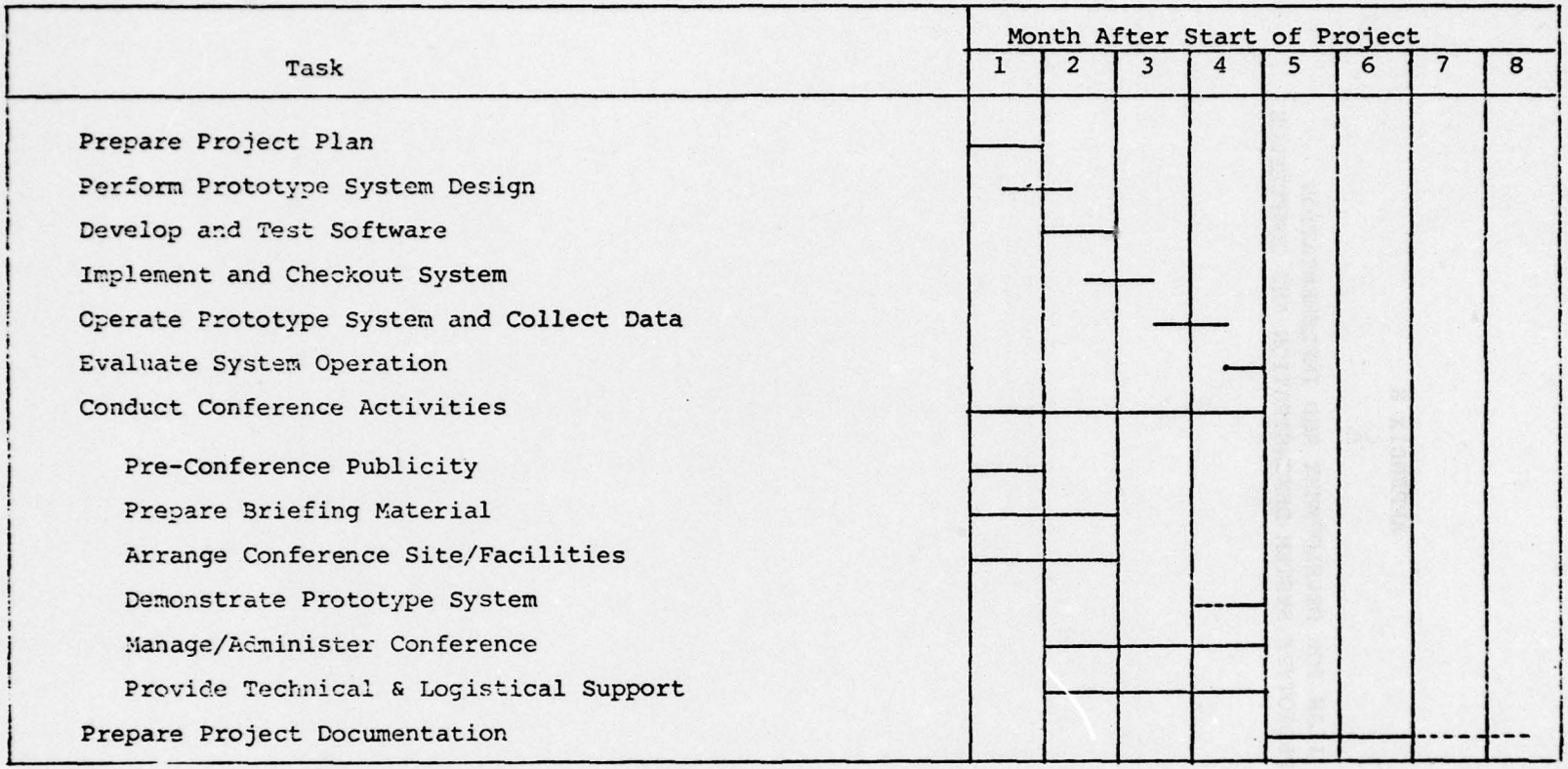

Figure H-1. PLAN FOR DEVELOPMENT AND IMPLEMENTATION OF PROTOTYPE SYSTEM DEMONSTRATION AND CONFERENCE